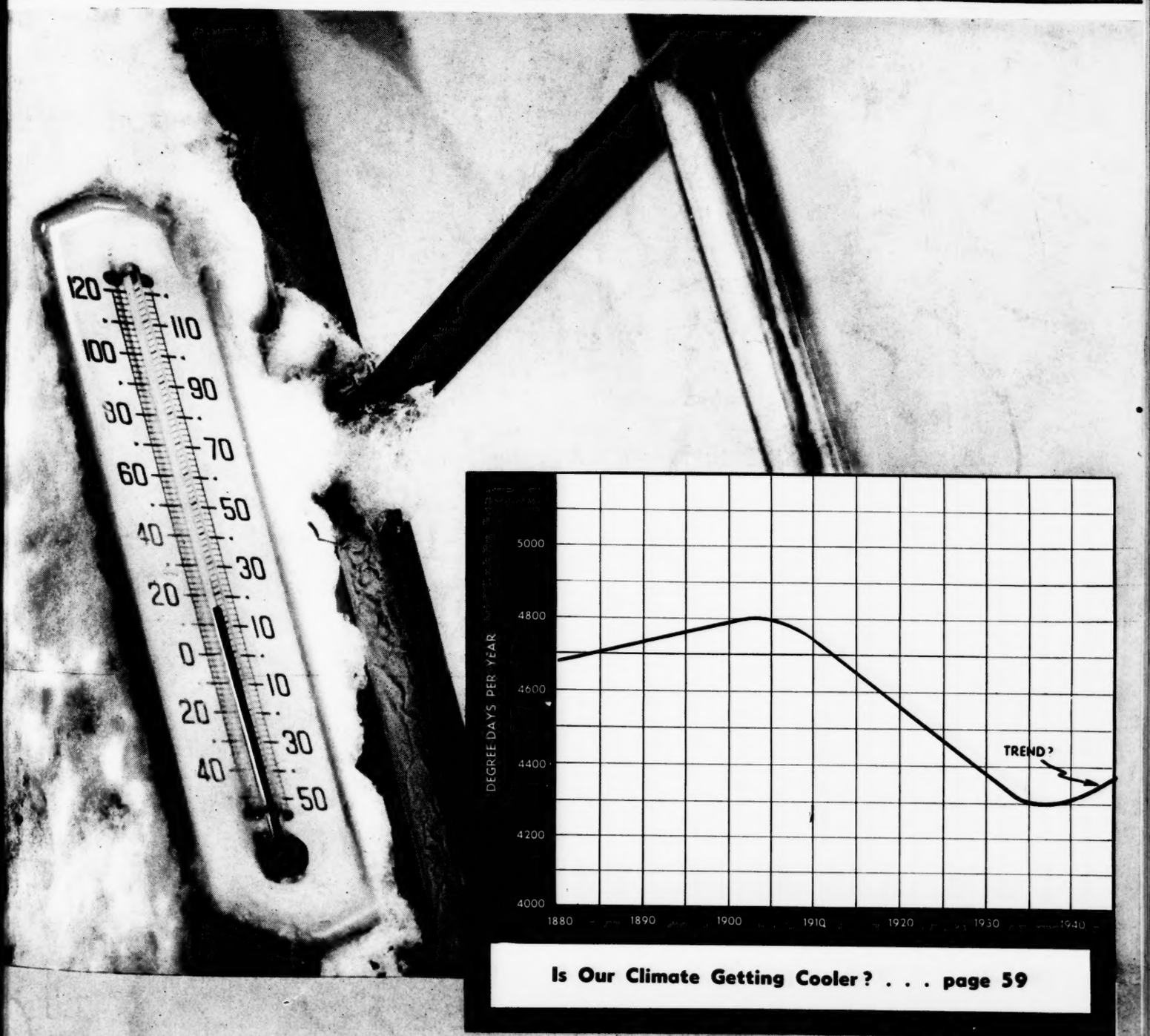
HEATING AND VENTILATING

AIR CONDITIONING, REFRIGERATION, PIPING, AIR SANITATION, HEATING AND VENTILATION



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MEMBER
Audit Bureau of Circulation
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THIS MONTH'S COVER

Insert indicates trend of 10-year degree-day averages for the city of Baltimore, Md., showing how recent winters appear to be getting cooler. See page 59. Photo by Lambert from Frederic Lewis.

Why Silentvanes are
first choice
for heating and ventilating

The Design 8 Silentvane, latest development of the Sturtevant Research laboratories, is the newest addition to the line of Silentvane fans which have been tested on the job in hundreds of installations like those shown below. In *every case* Silentvane fans have been outstanding. Here's why:

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Washington News

LORING F. OVERMAN

Political thinking.
An end to shortages?
Cut CPA housing approvals.
Production break-through imminent.

HOW badly those who try to stem the tide of highly vocal minority pressure groups need some sign from thoughtful Americans was indicated, rather more frankly than is customary, by Senator Owen Brewster of Maine, Republican, in an address before the annual meeting of the United States Chamber of Commerce at Atlantic City, May 2. Although some weeks have passed since he spoke, his remarks have not received wide publicity, and they would seem to deserve passing mention in this column at a time when "political decisions" are again setting the pattern of this country for the months ahead.

"The invitation to come here prompts some plain speaking," said Mr. Brewster. "Politics is a matter of salesmanship, like everything else. Now you doubtless entertain a delusion. You think of this matter of public service as something distinct and apart that a man goes into with the highest and holiest of motives. You assume that he is down there (in Washington) just to do what his conscience and the fear of Almighty God dictates. You take it for granted that is what he will do. Well, if he did that, he probably wouldn't be there very long.

Cynical or Dead

"Your president (Eric Johnston) has said you might like to know what a Congressman most wants to know from his constituents. What a Congressman wants to know from his constituents is whether or not they are going to vote for him! You may think that is a very cynical approach. If you take any other you become a dead politician. The cynical attitude, in my judgment, is expressed by what transpired in Washington. I think the average businessman believes that it is just a matter of our being dumb down there, that we don't understand. I accepted that thesis as I watched the show go on. I just thought the boys were a little inexperienced in business, trying to do the best they could. As time went on I became convinced there was something else operating. You may take the pattern of the last 12 years and apply it and make the best case for the rationalization of what is going on. Either there was a sinister intellect shaping it, or it had a curious parallelism. It was a design for chaos, out of which revolution might emerge.

"It is up to American business to devote at least a quarter of its time to community responsibility in various lines, to getting the confidence of Tom and Jim and Jack and talking this thing over with them. When we politicians come around they are likely to be a little cynical about it anyway. You have to have them sold before we arrive. Do that and we will take our stand. We are ready and eager to go along in the American way, but we are helpless unless we have the support of the people of the United States. That means support through the medium of the sound ideas which you can propagate if you will take a little time off from your business and dedicate it to the welfare of the community and the America we love."

So What?

Perhaps this bit of flag-waving deserves no place in a column devoted to Washington as it directly affects the heating, ventilating and air-conditioning industries. Yet to limit this column to effects, without mentioning suspected causes, seems a wasted opportunity. Now that the real extent to which votes determine the decision made in Washington is known, the question arises, "Do the voters who wield this tremendous power fully appreciate the advantages of 'The American Way of Life'?". Ask anyone whose first vote has been cast since 1932 and it will be painfully apparent that what America needs, and quickly, is re-education in the principles that made this country great.

"Hold Everything"

"Hold everything" seemed to have been the rule throughout the country as Congress went through its final deliberations on OPA, with the expectancy that July 1 would see some drastic changes in price rulings, with higher prices as the inevitable result. Foods and manufactured products were unquestionably held off the market awaiting the bell, creating further spot-shortages to aggravate the troubled market situation.

Despite the holdbacks there were evidences that the time is fast approaching when most of these shortages will be a thing of the past. The steel industry, for example, despite loss of 12,000,000 tons in production during the first half of the year, expects to produce between 35 and 40 million tons during the last half, bringing the 1946 total above the previous non-war peak of 53,205,000.

Third Quarter Steel Tight

For the third quarter, however, CPA has set up an emergency distribution program for steel to insure its going into products needed for the housing program, and for farm machinery. Included in the group for whom the government will issue certified orders are manufacturers of warm air furnaces and floor furnaces, convector radiation, furnace pipe, fittings and duct work; and steel registers and grills. The steel allocation program directs producers to deliver only on certified orders, as long as such orders are on file, and it applies only to primary steel shapes.

The return to allocation for a single quarter indicates the seriousness of the steel situation for the

from the drafting board up!

Here's something entirely new in open-type general-purpose motors . . . incorporating new design practices, improved materials and manufacturing methods developed through General Motors' varied resources.

Take a look first at the rugged frame. It has been redesigned to provide complete top-half enclosure that protects the interior from dripping liquids, falling chips, dropping particles. And inside you'll find other great new features: shielded and sealed type ball bearings, preventing grease leakage into windings—fewer parts requiring service—new improved ventilation and insulation. In fact, *everything* about this compact and sturdy motor points to peak performance, minimum maintenance and maximum life!

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DELCO MOTORS

DIVISION OF GENERAL MOTORS CORPORATION

next three months, but leaves room for hope that the steel industry's return to heavy production will signal the end of the strike-caused shortage before snow flies.

Housing Program

The status of the Wyatt program to build homes for veterans is full of question marks these days. There are those who believe that Wyatt could best serve the veteran by getting his directives and allocations out of the way of those who want to build higher-priced housing than is contemplated under the veterans' plan. Contention is that few veterans are in a position to build under today's high cost conditions; that they want rental units for the present anyway, and that the only ones who can afford to build as of today are prevented from doing so by current restrictions. Conclusion is that if those in a position to build better homes were permitted to do so, they would vacate less expensive quarters for veterans.

Others contend that by the end of 1946, the Wyatt program will have started construction of nearly 900,000 housing units—the goal for this year—but that fewer of them will be completed than had been hoped. That there is no scarcity of demand is borne out by the fact that a new order will put home building approvals on a weekly basis instead of a monthly one—the reason being that the number of approvals granted is exceeding the visible supply of building material. Applications have been coming in to CPA offices at the rate of 50,000 a week, which would mean 2,500,000 a year. The number of approvals is to be cut to 10,000 weekly.

Production Up

Encouraging thing about the program is that something is upping production of building materials. An index with V-J production as 100 shows all production high, ranging up to 240% for some items. This is still reportedly 10% to 50% below needs.

It was expected that by the end of June subsidy programs for nine scarce materials would have been announced. Programs for brick and plywood peeler logs were the first to be announced. Other programs nearing completion involved cinder block, pig iron, cast iron radiation, cast iron soil pipe, hardwood flooring, gypsum, and roofing materials.

To spike the diversion of construction lumber, CPA has brought production of every sawmill in the country, regardless of size and output, under government control. Previously it controlled those producing 8,000 feet of softwood or 4,000 feet of hardwood per day.

Super HH Rating Proposed

Reminiscent of the early days of war priorities is the recommendation of the plumbing and heating distributors Industry Advisory Committee that a super-HH preference rating be created to channel certain plumbing and heating fixtures into the emergency Federal Public Housing Authority program. The program involves emergency temporary re-use housing for veterans, including the moving and re-erection of 200,000 barracks units, Quonset huts and the like to educational institutions by September 30. The Industry Advisory Committee reported that HH preference ratings, the only type now available, are insufficient to command delivery of the needed equipment within the short time allowed.

Although the proposed rating would apply only to gas and oil-fired water heaters, lavatories, water closets, sinks and steel shower stalls, creation of such a super-HH rating might be the forerunner of other such special ratings extending into other fields.

Break-Through Imminent

Regardless of the fate of the Price Control Act or the efforts of various government agencies to channel materials or to direct the country's economy, indications are that the second half of 1946 will witness a production breakthrough that will make itself felt in nearly all fields, with the possible exception of construction and automotive. Backlog of demand is so heavy in these fields that some years will be required to take up the slack.

Washington is now of the opinion that major strikes are past, and that while there will be important numbers of smaller strikes, there will be none that will affect the economy as a whole. This should permit a rapid pickup of production in nearly all lines. Union organizers too, it seems, are as election-conscious as are legislators, with the result that they are in no mood to stir up public resentment between now and ballot-casting time.

Thus the goal of Government and labor as a whole may be expected to be one of "hands off" for the next few months, letting increased production and continuing prosperity lull the citizenry into a sense of assurance that everything is fairly well on the beam. It is rather expected that another wave of strikes will follow the November elections, for it is anticipated that price increases will have wiped out the financial gains of previous strikes.

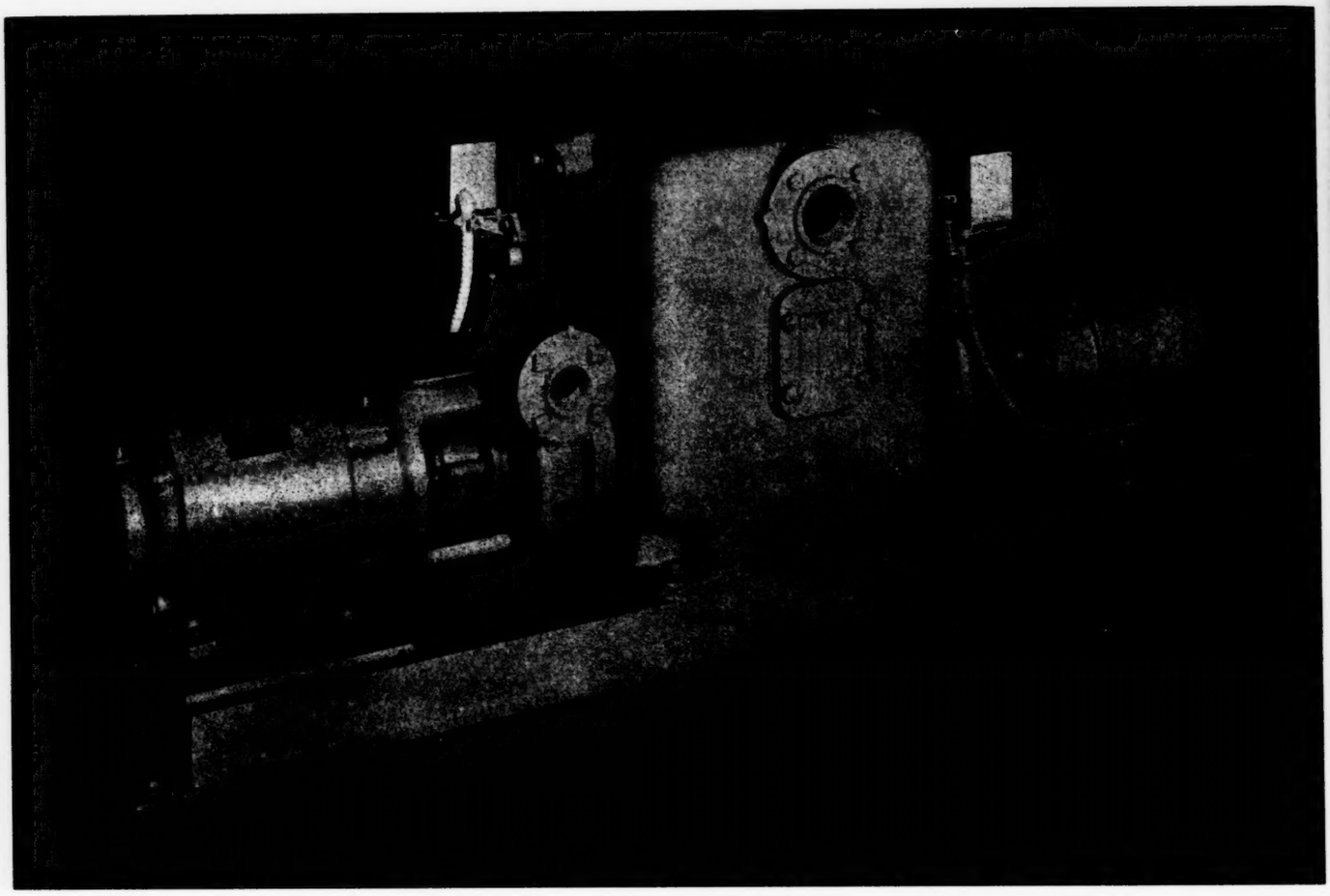
All in all, it would appear that the last half of the year will offer at least a breathing spell—with Congress electioneering and with strikers recouping their finances. It is to be hoped that a taste of new goods on the market and a respite from new legislation will prove to be a sample worthy of continuing.

Washington Miscellany

Fan Ceilings Raised: Revised Maximum Price Regulation 136, Order 645, grants interim price increases to manufacturers of all power-operated warm air furnace fans and blowers, attic ventilating fans, exhaust fans and blowers. Increase is 14 percent for fans and blowers when furnished with power unit of less than one horsepower and 9 percent for those of one horsepower or over.

Radiator Ceilings: MPR 591, Section 22, Order 1 and MPR 272, Amendment 10, effective June 25, brings cast-iron and gas-fired steam radiators under same pricing formula as other cast-iron radiation, permitting the former the same price increases granted under the regulation April 30, 1946. Also clarified transportation charges provision for manufacturers of cast-iron radiation, boilers, boiler repair parts and radiation accessories.

MAXIMUM EFFICIENCY FOR STEAM HEATING SYSTEMS ON HEATING, DRYING AND PROCESS WORK.



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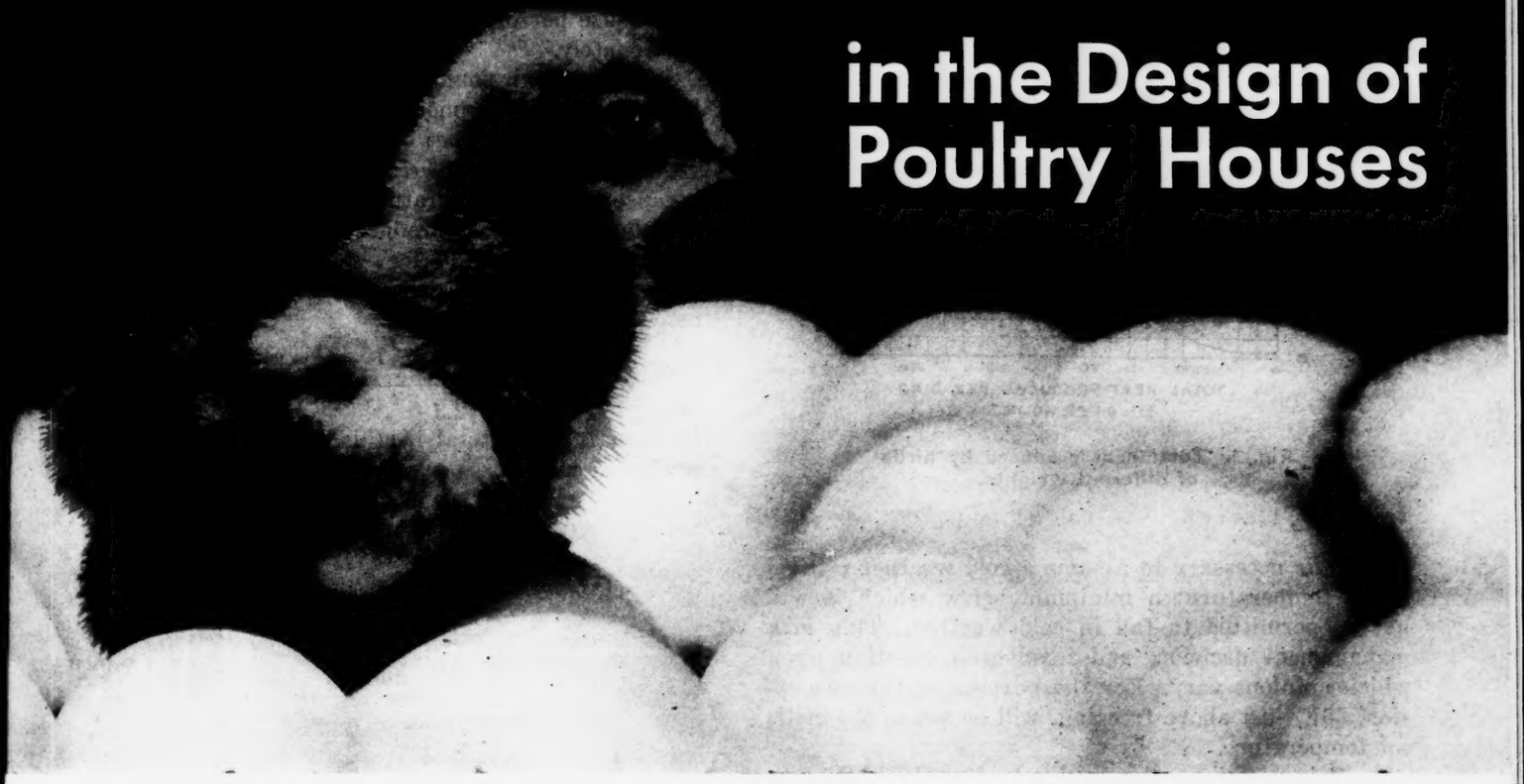
Heat and Ventilation in the Design of Poultry Houses



This article presents design data on the control of laying house temperature and humidity using the hen as the sole generator of heat and moisture.

J. L. STRAHAN
Agricultural Engineer, The Flintkote Co.

HERE are rather wide differences of opinion as to what sort of protection a laying house should afford. Lately the argument seems to be going in favor of the house where temperatures are kept above freezing; because it has been demonstrated that a correct manipulation of the design factors of insulation, ventilation, and house population will result in good performance in the coldest weather, and even then, house temperature will remain below the freezing point for only a short period. It is probable that preventing a drop in egg production, plus savings in feed and labor will combine to make the added investment in insulating materials a profitable one, particularly in the case of the large enterprise.

However, it is not the purpose of this article to argue the relative merits of management methods, but rather to present principles of design for the use of those who wish to maintain the greatest possible degree of control over inside temperature and humidity in cold weather consistent with good building investment economy; and to indicate the limitations of resulting designs when no artificial heat is used.

Heat and Moisture Production

Table 1, including data taken from an early study[1], shows how heat production varies with live weight.

The data have been plotted, heat against weight, resulting in the curve shown in Fig. 1.

Table 1—Total Heat Production by Domestic Fowl

Weight, Pounds	Total Heat Produced		Weight, Pounds	Total Heat Produced	
	Cal. per Day	Btu per Hr		Cal. per Day	Btu per Hr
0.07	10	1.65	2.0	155	25.62
0.50	82	13.56	3.0	194	32.07
1.00	110	18.18	4.0	235	38.85
1.50	132	21.82	5.0	281	46.45

It has also been shown that the percentage of total heat that is in latent form, heat of vaporization of respired moisture, varies with environmental temperature in the manner expressed by the curve in Fig. 2.

In order to obtain basic data for design purposes from these two curves, two assumptions are necessary.

[1]Mitchell and Kelley, University of Illinois; "Estimated Data on the Energy, Gaseous and Water Metabolism of Poultry for Use in Planning the Ventilation of Poultry Houses"; Journal of Agricultural Research, November, 1933.

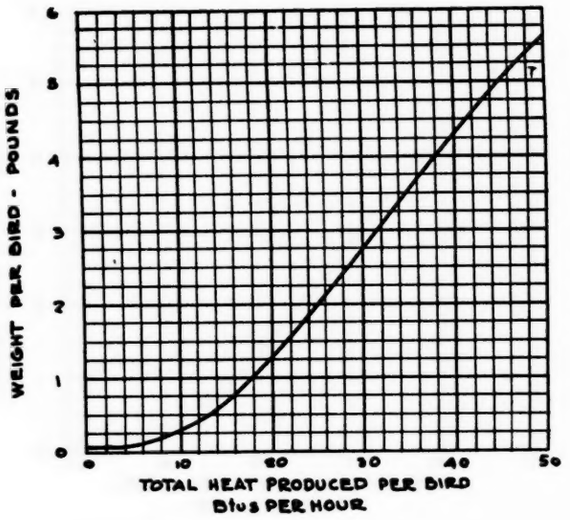


Fig. 1. Total heat produced by birds of different weights.

1. It is necessary to assume a cold weather critical house temperature; a minimum below which it will not be permitted to fall in cold weather. This is a management decision, and involves a question upon which opinions vary. For the purpose of this discussion, 35F, just above freezing, will be set as the critical temperature.

2. It is necessary also to standardize the bird as to size, and the population of the house as to density. It is here assumed that birds in the house will weigh 4 lb, and be allowed 3.2 sq ft of floor space each. Under these assumptions, it will be possible to estimate the amount of moisture to be removed, and of heat available to remove it.

Again, it must be recognized that opinions differ as to density of population. Some authorities insist that 4 sq ft per bird is the minimum permissible. Others, and some of these are practical growers making a living from their flocks, get satisfactory results at 3 sq ft per bird. No doubt, the first group are frequently thinking in terms of heavy birds, while many of the second handle light breeds. But heavier and fewer birds in the house will make practically the same amount of heat and moisture as will a larger flock of lighter birds. The engineering problem is practically the same in either case. If the size of the flock (live weight housed) varies to any great extent above or below the assumed amounts during the season, house performance may be expected to vary proportionately.

Where a four pound bird is housed at 35F, it can be stated that the amount of heat it will provide (in sensible form) will be:

$H_s = 38.8 \times (100 - 7.9)\% = 35.7$ Btu per hr

because at that temperature, 35F, curve 2 states that 7.9 of the total heat produced will be in latent form, and the balance, or 92.1%, sensible.

Furthermore, it can be stated that the amount of moisture produced will be:

$$W = \frac{38.8 \times .079 \times 15.43}{2.3} = 20.6 \text{ gr per hr}$$

because 7.9% of total heat is latent, there are 15.43 grains of moisture per gram, and it takes 2.3 Btu to vaporize 1 gram of water at skin temperature (approximately 86F). Twenty-one is the figure used in the present discussion.

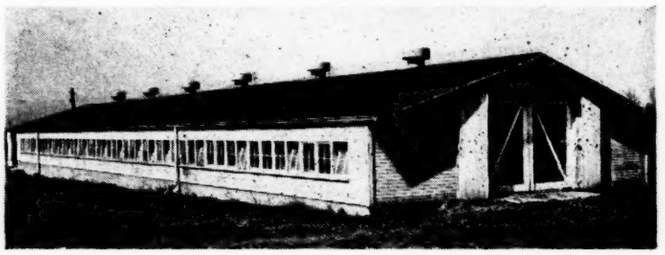


Fig. 3. Creighton type poultry house, 30 ft x 110 ft.

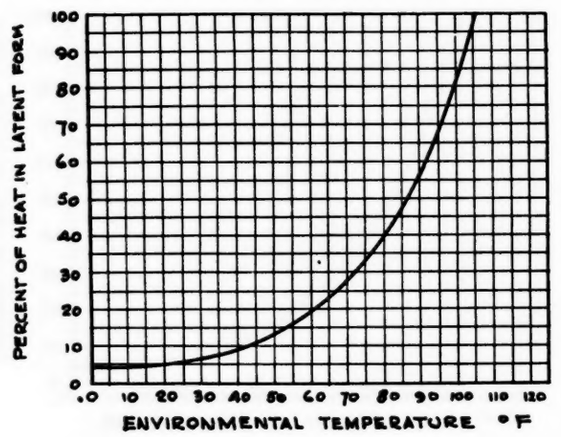


Fig. 2. Percent of heat in latent form at different environmental temperatures.

General Design Principles

Compared to a cow, the hen is obliged to occupy very spacious quarters. Because the headroom in the building is limited by the requirements of the attendant, the minimum space in a hen house per pound of live weight housed is about 4.8 cu ft, whereas in the cow stable, it is about 1.7. Translated into more significant design factors, the amount of heat produced by the hen per square foot of exposed enclosing surfaces, is from 5 to 6 Btu per hr, while the cow produces from 20 to 25 Btu per hr per sq ft of enclosure. Obviously, the hen would require that about 4 times as much resistance to heat flow be built into her house to get the same amount of protection.

Observations of practical operations indicate that if ideal functional design specifications were set up and allowed for in strictly rational procedures, it would be found that the insulation required to meet these conditions, both as to cost and amount, would be out of proportion to the presumably ideal benefits thereby conferred. Therefore, a more practical approach appears to be to set up wall and ceiling specifications containing as much insulation as can be included within reasonable structural and economic limitations and then to determine the degree of protection that such construction will provide. Recommendations for climatic adaptations and the use of insulation can be based upon the results of this analysis. In other words,

maximum protection will be limited by the ability of the birds to provide heat. Fortunately, it will be found possible in practice to operate profitably within this limitation.

For special situations calling for more protection than can be provided by biological heat alone, the method will furnish the basis for estimating whatever additional artificial heat may be required.

Application to Typical Case

In Warsaw, Indiana, the Creighton Brothers, large producers of poultry, have developed a laying house which has been promoted by the Purdue University Extension Service because it conforms to the fundamentals of good design. It has low side walls and a gently sloping roof as shown in Fig. 3. A typical 30 ft x 30 ft section is shown in Fig. 4 and 5 and is used here to exemplify the effects of insulation on house performance.

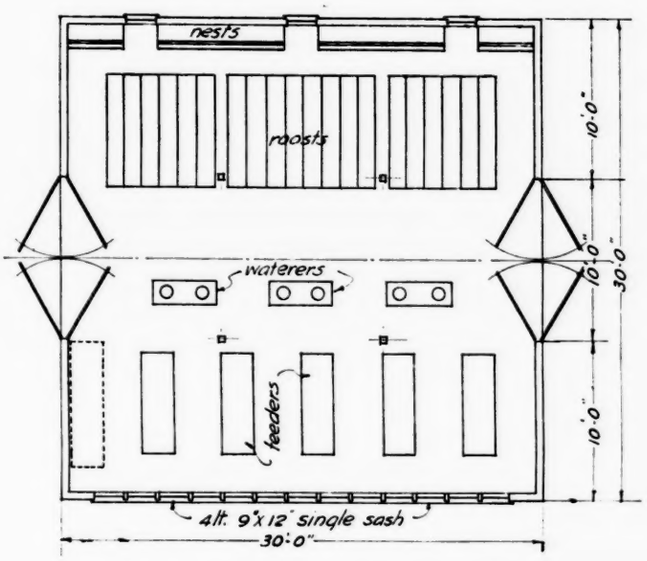


Fig. 4. Plan of Purdue type laying house.

If birds are housed at 3.2 sq ft each in the 30 ft x 30 ft house, it would leave a normal population of 281. The total area of exposed surfaces is 1720 sq ft allowing 6.121 sq ft per bird. If heat produced per bird at 35F is 35.7 Btu, then heat available per sq ft per hr will be 5.68 Btu, an amount which experience indicates to be sufficient to maintain a reasonable and satisfactory degree of conrol. It will be of interest to set up insulation specifications for this building and then to analyze the design in detail to develop proper climatic recommendations and ventilation requirements.

Table 2 indicates the thermal characteristics of the various major structural elements of the building, when built and operated to the following specifications.

1. Walls to be sheathed outside with 25/32-in. insulated sheathing covered with asbestos cement siding. Inside surface to be covered with ½-in. insulating board over a vapor seal paper and protected with asbestos cement board as high as hens can reach to prevent pecking. Space between the studs to be filled with a pour type insulating wool.

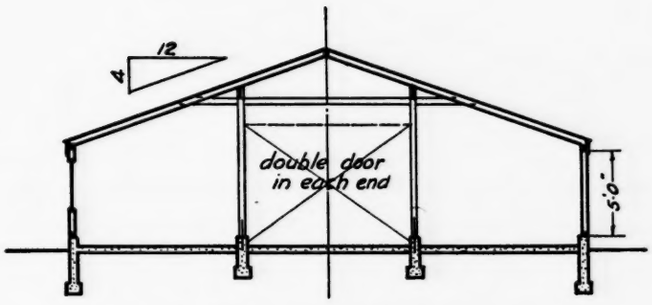


Fig. 5. Section through laying house.

2. Roof to be covered with an asphalt roofing on a tight wood deck, the under side of the rafters covered with 25/32-in. insulated sheathing over a vapor seal paper, and a pour type insulating wool filled between the rafters. Inside surfaces of insulating board, both walls and roof to be painted with two coats of asphalt base aluminum paint. (See Fig. 6)

3. Storm sash to be used on all windows.

4. Doors to be made of two thicknesses of lumber with building paper between the layers.

5. Floor litter is built up to the top of the foundation wall, thereby practically eliminating that item as a heat loss factor.

Table 2 – Analysis of 30 ft x 30 ft Purdue Laying House, Full Insulation

Unit	Area	U	R	Heat Loss
Walls	562	.0543	18.42	30.52
Windows	48	.45	2.22	21.60
Doors	150	.37	2.70	55.50
Roof	960	.0587	17.71	56.35
Total	1720			163.97

If 281 birds are housed, the area of exposure per bird, (A), will be 1720 ÷ 281 = 6.121 sq ft.

Since a total of 163.97 Btu's are lost from the house per hour per degree of temperature difference, the average loss per square foot, (C), will be 163.97 ÷ 1720 = .09533 Btu.

The value of A × C, heat loss per bird per hour per degree of temperature difference, will be 6.121 × .09533 = .5833 Btu.

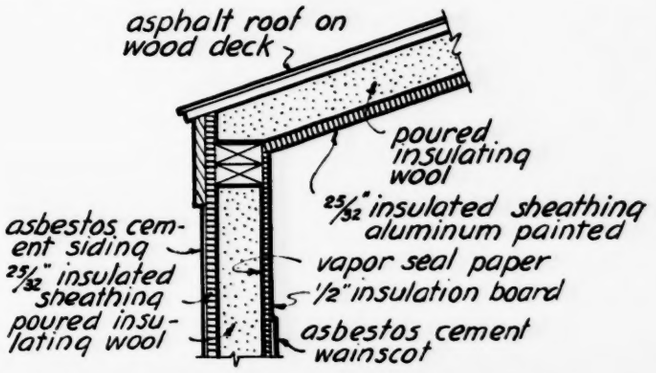


Fig. 6. Insulation specification No. 1. See Fig. 7.

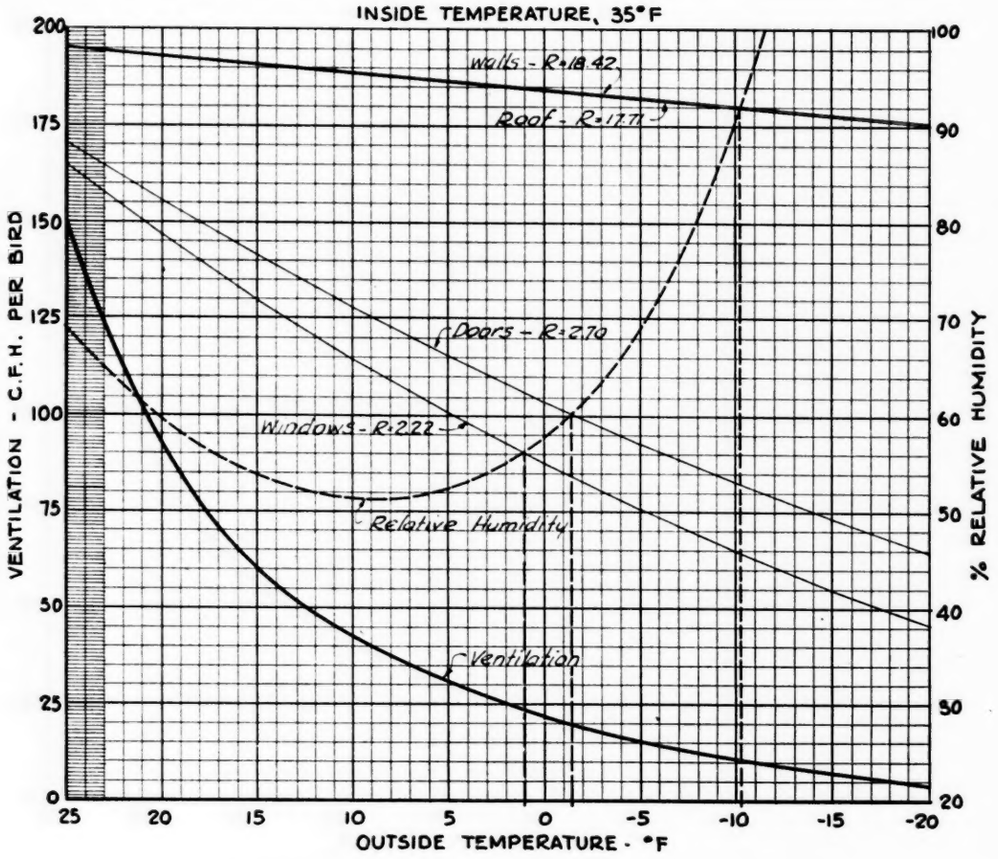


Fig. 7. Performance chart for insulation specification No. 1.

Proper performance, or the maintenance of a dry house at a reasonably uniform temperature, requires that the rate of air change be varied inversely as temperature difference varies. This is obvious when it is considered that heat production is practically constant and that heat loss by radiation and conduction increases with increase in temperature difference. The relation can be expressed as a balance between heat production and heat loss, as was discussed in an article on dairy stable design in the January, 1946, issue of this magazine. For the record, the formula is repeated here, but related to poultry:

$$H = \frac{VD}{50} + ACD$$

in which

- H = Heat produced in sensible form in Btu per hour per hen
- V = Air change in cfh per bird
- D = Temperature difference
- AC = Heat loss by radiation and conduction per hour per bird per degree of temperature difference
- 50 = Cubic feet air raised 1F by 1 Btu at an environmental temperature of 35F

In investigating the performance to be expected from the design under discussion, it is first desirable to determine the manner in which ventilation must be varied during periods of falling outdoor temperatures, and then to compute the effect of this variation in air flow upon inside relative humidity. It will be apparent that a point will be reached below which ventilation cannot be restricted without causing a concentration of moisture in the air of the house sufficient to result in condensation and frosting on inside wall and ceiling surfaces. The amount of insulation, which controls inside surface temperatures, will, of course, determine just when this effect may be expected to occur.

To determine volume of air change required to maintain the inside temperature, it is first necessary to transform the heat balance formula to state the value of V in terms of all the other factors. Thus

$$V = \frac{50\ (H - ACD)}{D}$$

By substituting appropriate values for known factors, volume of air change required to hold inside temperature at 35F at any specific outside temperature can be computed. For an outside temperature of 25F, it will be

$$V = \frac{50\ (35.7 - (.5833 \times 10))}{10}$$

$$= 5 \times 29.9 = 149.5 \text{ cu ft}$$

Similar computations for other outside temperatures in 5-degree increments produced the data from which the ventilation curve, Fig. 7, was plotted.

The data for relative humidity were computed on the following assumptions:

(1) Inside temperature remains constant at 35F,
(2) Moisture production remains constant at 21 gr per bird per hr, and
(3) Incoming air is saturated at outside temperature.

The total amount of moisture to be removed per pound of outgoing air at each 5-degree outside temperature point was related percentagewise to the

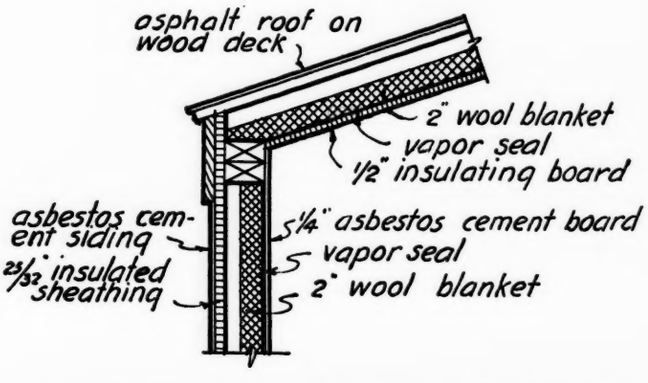


Fig. 8. Insulation specification No. 2. See Fig. 9.

amount which would be present per pound if the inside air was saturated at 35F. The results were plotted using the right hand vertical scale for relative humidity.

Referring to Table 2, it is shown that walls and ceilings have a high thermal resistance, 18.42 and 17.71, respectively. Windows and doors have comparatively low resistance. It is of interest to determine the effect of these resistances upon control of condensation under operating conditions. To accomplish this, condensation lines were drawn on the chart, Fig. 7, one for each element of the construction. These are the light weight lines that extend diagonally across the chart from a relatively high point on the left to a relatively low one on the right.

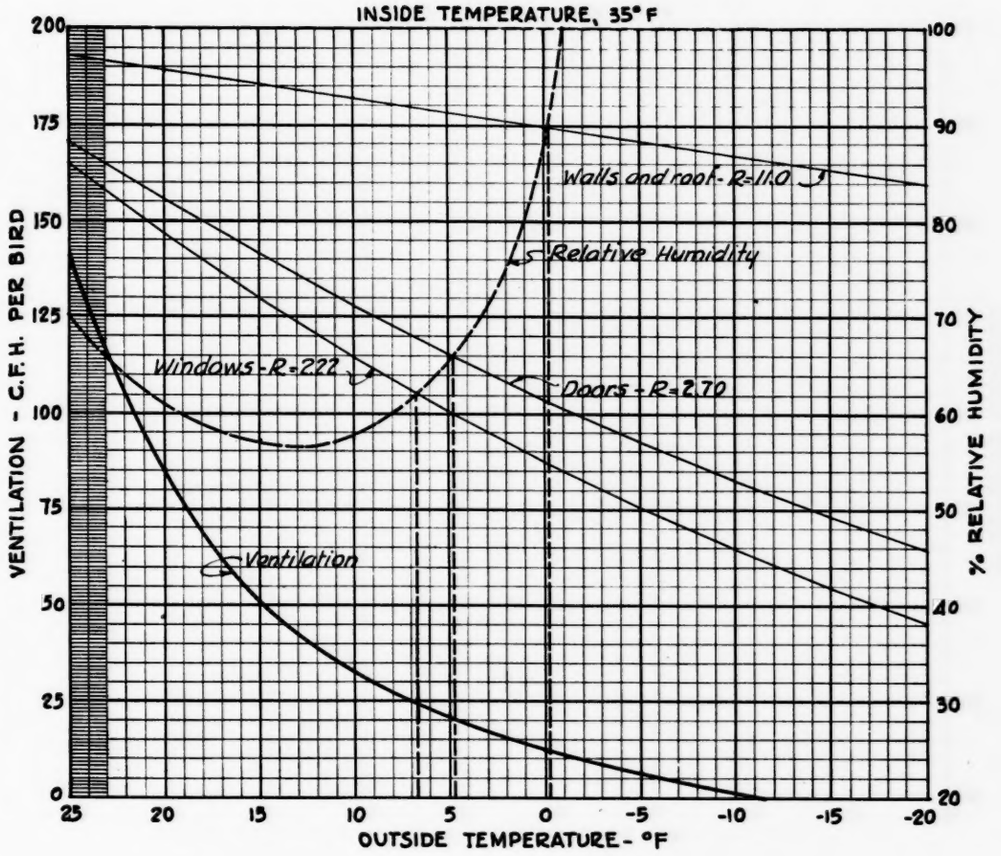


Fig. 9. Performance chart for insulation specification No. 2.

To plot these lines, the inside surface temperature was first determined for each 5 degrees of outside temperature, assuming the surface value of K to be 1.2. The amount of moisture present per pound of air when saturated at this inside surface temperature was related to the amount which would be present if saturated at 35F in order to compute the inside R.H. at which condensation would occur.

It will be observed that the resistance lines all cross the relative humidity curve each at a different point. The point of intersection indicates the events at the occurrence of condensation or frosting. For instance, the resistance line for the windows crosses the R.H. curve at an inside relative humidity level of 56%, which occurs when ventilation has been restricted to 23 cfh per bird. This will happen at 1F above zero if inside temperature is maintained at 35F. The doors will resist condensation until R.H. rises to 60% at —1½F, ventilation then being restricted to about 19 cfh. So far as windows and doors are concerned, it can safely be predicted that the house will be dry at outside temperatures at or near zero.

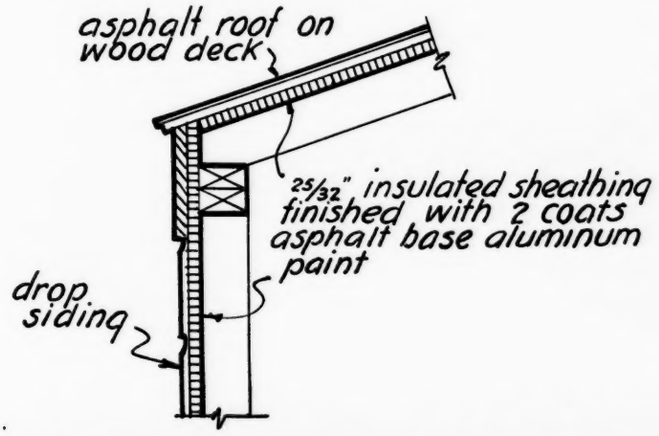


Fig. 10. Insulation specification No. 3. See Fig. 11.

On the other hand, the chart shows that the walls and ceilings, having high resistance, will stay dry until outdoor temperature drops just below —10F. Ventilation can be restricted to about 11 cfh per bird and R.H. can rise to 92% before condensation will occur here. As these constitute by far the largest elements of surface, and as some condensation is not particularly objectionable on windows and doors, it is proper to state that this insulation specification will be adequate in areas where a temperature of —10F can be expected over fairly long periods. In even the coldest areas, a lower temperature than this does not persist for very many days at a time. Furthermore, during such times as it might do so, relief from condensation can be obtained by allowing inside temperature to fall below freezing. The birds will not suffer and precautions can be taken to prevent water pipes from being seriously damaged. At least the operator has a choice between a short period of freezing and some slight condensation on walls and ceiling.

A more critical situation is likely to occur at comparatively high outside temperatures, between 20 and 25F. Ventilation must be increased rapidly as outside temperature rises towards the freezing point if inside temperature is to be held at 35F, more rapidly than can well be justified when considering fan cost, and the possibility of producing drafts in the house. Even with this increased air flow, relative humidity con-

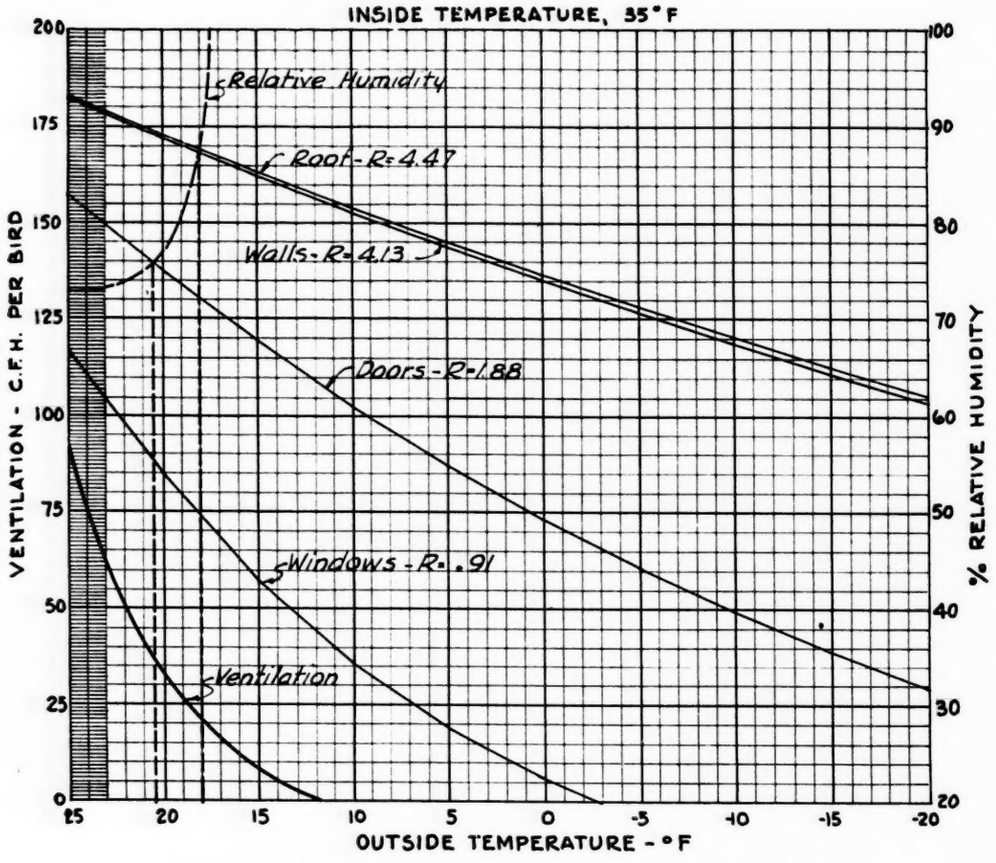


Fig. 11. Performance chart for insulation specification No. 3.

tinues to rise. The obvious solution is to permit inside temperature to rise at a rate approximately parallel to outdoor fluctuation. Under this management, humidity will be checked and the house will remain dry. There will come a time, however, when all windows and doors must be left open and all attempts to control inside temperature be abandoned.

Ventilation

During summer, it has been observed that insulation has the effect of holding inside temperature below outside during very hot periods when birds would otherwise suffer. Night operation of the fans and daytime restriction of ventilation has the effect of leveling off the temperature curve advantageously. In this connection, it helps to have the house protected by shade trees.

Fig. 8 and 9 illustrate a specification calling for less insulation, and the performance that can be expected from its use. Instead of a fill 3⅝ in. thick, a 2-in. wool blanket is used in walls and roof. The inside wall surface is covered with asbestos cement board over a vapor seal paper, and the rafters are covered on the under surface with ½-in. board instead of 25/32-in. sheathing. Wall and roof resistances are reduced from approximately 18 to about 11. The performance chart (Fig. 9) indicates that condensation will be prevented on walls and ceiling down to an outside temperature of zero, about 10F higher than specification No. 1. Ventilation at zero is restricted to 12 cfh, and at the higher temperatures, it ranges between 100 and 135 cfh per bird.

When all wool insulation is omitted from the specification, as shown in Fig. 10, and only 25/32-in. sheathing is used on the outside of studs and rafters, performance is not adequate for any climate north of the Mason & Dixon line. The chart (Fig. 11) shows that condensation can be expected to occur at 18 above zero if inside temperature is held at 35F by passing 20 cfh of air per bird through the house. This is at a temperature difference of 17F, as against 35F for the second specification and 45F for the first. The effect of varying the amount of insulation upon the adaptability of the design to climate is clearly indicated and is very marked.

Table 3 recapitulates the basic design characteristics of the three specifications illustrated and states in specific terms the performance to be expected when ventilation is adequate and under control.

In general, it may be concluded that when a design provides for an AC characteristic of .6 or lower, it will be adequate for the colder areas of the country. An area of exposure of 6.1 or 6.2 sq ft per bird, wall and ceiling resistances of from 17 to 19, the use of storm sash or insulated doors will result in this value for AC. For areas where temperatures are not so severe, in the lower sections of the northern half of the country, a relaxing of the insulation specifications appears to be reasonable and justified, but not down to the point where insulation board or sheathing alone is provided. It is safe to say that unless enough insulation is used to cause the value of AC to be less than 1.0, it would be better to revert to the uncontrolled system of management and permit the house temperatures to fluctuate just about parallel to outside temperatures most of the season.

Table 3 — Performance When Inside Temperature Is 35F

Specification	AC	U		R		Critical Outside T	Ventilation Cfh per Bird	
		Walls	Roof	Walls	Roof		Restricted	Max.
1	.576	.0543	.587	18.42	17.71	— 10F	11	150
2	.770	.0904	.0922	11.06	10.85	0F	12	140
3	1.506	.233	.224	4.30	4.47	+ 18F	20	86

Ultraviolet for Air Sanitation

ARTHUR R. DENNINGTON
Consulting Engineer, Bloomfield, N. J.

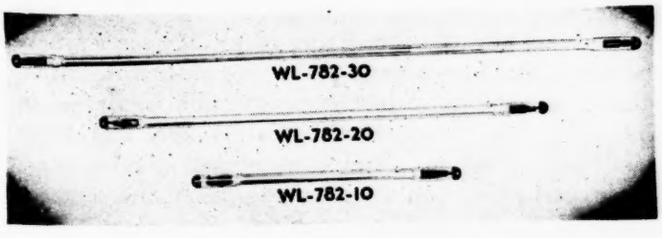
SANITATION is the newest-plus treatment given to air used to heat or cool homes and buildings. Its purpose is to kill or inactivate airborne microorganisms which may cause illness or, under aggravated conditions, cause epidemics. Such air sanitation is achieved through the use of germicidal ultraviolet lamps in addition to the electrostatic cleaning or mechanical filtering of the air.

The germicidal action of ultraviolet light has been known for a long time. However, it has been only within the last decade that artificial generation of the germicidal wave lengths has reached an economical basis. Special glass had to be developed which, while it would permit the passage of a high percentage of radiation in the wave length region of 2,537 angstroms, would limit the very short wave lengths below 2,000 angstroms. An angstrom is a minute unit of measure so small that 250 million are required to equal one inch. Limitation of the wave lengths below 2,000 angstroms is essential to keep the amount of ozone produced within the tolerance limits of one part of ozone per ten million parts of air as specified by the Council of Physical Therapy of the American Medical Association.

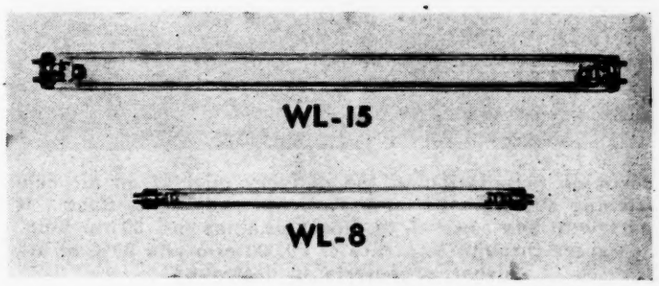
Isolated Rooms

The term isolated room may be applied to the section of a building which is not interconnected by air ducts with other sections. Such rooms are usually heated by steam or hot water radiators. The interchange of air with other rooms is incidental through doors and hallways. Under these conditions the objective is to protect room occupants from cross infections set up by each other, since persons in the room may have some infectious disturbance which can be communicated to others through air.

Normally the air from each person rises because of body heat and descends due to random air currents produced in part by the heating equipment, cold walls and windows. This random air circulation effectively distributes airborne organisms to all parts of the room and to all occupants. Protection from infection can be obtained by placing fixtures containing germicidal ultraviolet generators on the walls or suspending them from the ceiling. Because ultraviolet rays are irritating to unshielded eyes, it is essential that fixtures be provided with reflectors to cut off the direct or strongly reflected radiations from the occupied area. Radiation must be directed into the upper portion of the room above the eye level.



Cold cathode bactericidal lamps. Reading from the top down, 30-in. unit consumes 18 watts, 20-in. lamp consumes 12 watts, and 10-in. lamp uses about 10 watts. Lamps are normally ½ in. in diameter and because of small diameter are preferred for installation in plenum chamber of air ducts.



Hot cathode bactericidal lamps. Illustrated is the 15-in. lamp, ⅝ in. dia. which consumes about 8 watts, and the 18-in. unit, 1-in. dia. which uses 15 watts. Not shown is the 36-in. lamp which consumes 30 watts.

Wall fixtures with horizontal cut-off of the radiation are preferable and should be mounted about 6½ ft above the floor. These fixtures should also have a vertical cut-off to prevent direct rays reaching the wall except at a distance of three feet or more above the fixture. If the germicidal rays reach the wall just above the fixture, the paint, paper or drapes near the lamp will fade. Considerations of clearance dictate that fixtures suspended from the ceiling be hung at least 7 ft above the floor. Inasmuch as it is desirable to irradiate as large a portion of the room air as possible, fixtures should be placed as low as practical.

Experience has shown that radiation of the upper air in a room results in a marked reduction in bacterial infection and consequent loss of time of the occupants. For example, in the second and third grade classrooms of the Elm St. School, Plattsburg, N. Y., a record of absences due to respiratory diseases revealed that while 240 pupils were absent for a total of 652 pupil days in the second grade where no ultraviolet radiation was provided, there were only 119 pupils absent for a total of 219 pupil days in the third grade where ultraviolet radiation was provided. Other records substantiate these results. At Camp Sampson, N. Y., where half the barracks of one group were irradiated and the other half were not, during the winter of '43 and '44 the number of sailors reporting for sick call due to infections from airborne organisms was about 30% less from the irradiated barracks. In another installation in the Swarthmore, Pa., schools,

Sterilamp installation in the delivery duct of an air conditioning system; 104 lamps were placed in the duct 1 ft apart with the rows 15 in. apart. Lamps are 30 in. long. Air passes through at a rate of 40,000 cfm and 95% of all airborne bacteria is destroyed.

the incidence of measles in an irradiated classroom was reduced to one fifth that in a comparable room where there was no germicidal ultraviolet radiation.

The amount of radiation to accomplish reductions in infections can be obtained by installing one 30-watt hot cathode Sterilamp for each 150 to 200 sq ft of floor area. The larger area may be specified where the ceiling height is 16 ft or more and the smaller area where the ceiling height is about 10 or 11 ft. Intermediate areas would be specified for ceiling heights between the limits mentioned.

The system of indirect radiation can also be used in rooms which are ventilated and heated or cooled by means of a central air supply or conditioning system. If all the rooms served by a single air conditioning unit are irradiated by wall or ceiling type units, the number and arrangement will be about the same as it is for isolated rooms. In buildings where only part of the rooms are provided with germicidal ultraviolet radiation, the best results will be obtained by locating some of the wall type radiation units just below the incoming air registers when these are located seven or more feet above the floor. Such an arrangement will provide the greatest intensity of radiation possible for the incoming air. It is usually impractical to irradiate air entering a room through registers placed near the floor.

Sanitizing Air in Ducts

As the air supplied to various areas by an air heating or conditioning system is a mixture of two-thirds or more recirculated air and fresh air, the level of contamination is much greater than if it were all fresh air. Economy of heating and cooling determines the use of recirculated air and thus the need for air sanitation by means of ultraviolet radiation.

There are two locations in an air conditioning system for the installation of germicidal ultraviolet generators. These are: first, the plenum or service chamber between the filters and the fan intake; and, second, in the main supply duct between the fan and the first outlet. Questions of economy, accessibility and effectiveness must be considered in making the choice of location for the lamps, which in this case should be of the cold cathode type.

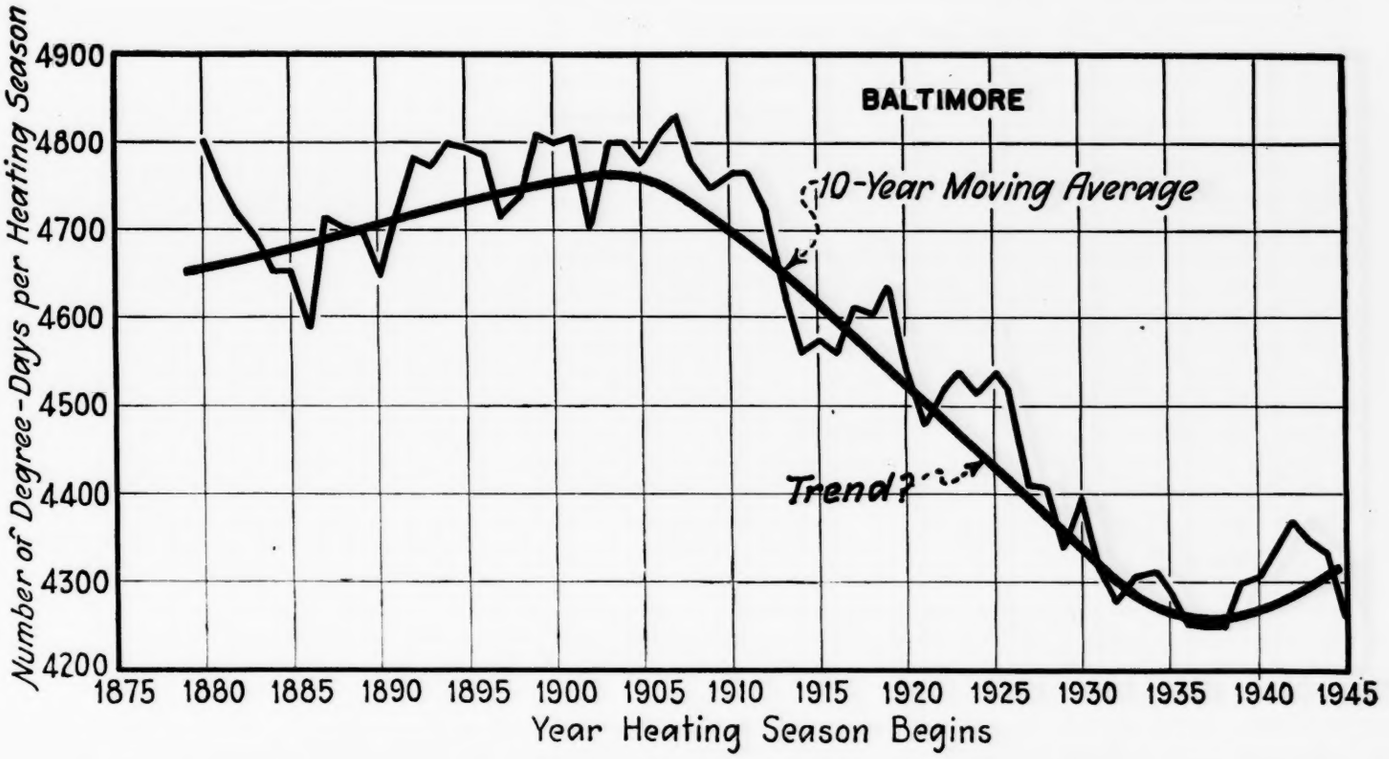
The plenum chamber offers the advantage of low air speed, about 300 fpm. It is thus possible to radiate effectively the air in a smaller space. While practical considerations of servicing Sterilamps dictate a minimum length of 3 ft for the radiation chamber, a length of at least 6 ft is desirable. Radiation units should be installed so that only clean air passes over them; this will be between the electrostatic air cleaner or filter bank, and the heating and cooling coils. The recirculated air duct must be brought into the plenum chamber ahead of the radiation chamber. The ultraviolet lamps should be mounted vertically on a stationary or a movable rack and spaced uniformly apart in one or more grids across the chamber. Inspection windows should be provided in the service doors so that a casual glance will tell if all the lamps are operating. As radiation intensity in the chamber is high, a switch to open the primary circuits of the transformers should be installed on the service door. This switch prevents anyone entering the radiation chamber when the lamps are operating.

The second method of installing germicidal ultraviolet lamps is in the main air duct leading from the fan. As in the case of lamps in the plenum chamber, greatest efficiency is obtained by placing the lamps at right angles to the air flow and uniformly spaced in grids across the duct. Grids are spaced along the duct in succession and are spaced about 6 to 15 in. apart. The wider spacing is chosen if there is sufficient straight length of duct to accommodate the required number of lamps.

In most cases the duct width or height must be changed to fit the length of the lamps installed. For example, for an installation of 30 in. cold cathode Sterilamps, one dimension of the air duct should be at least 36 in. as this is the mounting distance between sockets. This space must be provided where the lamps are installed on racks in plenum chambers. Where the duct width or height is greater than 36 in. but less than 72 in. the sockets at the inner ends of the lamps can be overlapped. The spacing of the lamps across the radiation chamber should not exceed 15 in. for it is desirable to keep the maximum distance that any particle of air can pass a lamp to less than 8 in. By means of the grid system of lamp installation, the air is forced to pass close to one or more lamps and the maximum radiation passes the duct lengthwise with minimum absorption on duct walls.

Combination Installations

The most effective sanitizing of air in places where the occupants do not wear protective shields is accomplished by combining indirect germicidal radiation in the room with radiation of the air supply in the air conditioning system. This arrangement insures practically germ-free air entering the room and a great reduction in the number of living organisms transmitted from one person to another in the room. Double protection is provided by the combined method and the air is rendered as safe as present scientific treatment can make it.



10-year moving average of degree-days for Baltimore showing the trend toward warmer winters from about 1905 to 1936. The curve suggests, but does not yet prove, a possible reversal of this trend.

Is Our Climate Getting Cooler?

J. B. KINCER*

Twelve years ago the author prepared a paper for the "Monthly Weather Review," which was reprinted in HEATING AND VENTILATING, summarizing evidence that in the U. S. each of the seasons and the years as a whole were getting warmer. Apparently, the low point of the cycle was reached only a few years later, for data for subsequent years seem to indicate that we are now reversing that trend and that the seasons are getting cooler. The accompanying article is abstracted from a paper presented by Mr. Kincer at the May meeting of the American Geophysics Union.

IN a previous paper the author discussed long-time temperature trends, and presented data showing that an unusual and extended warm phase of climate had at that time developed through a more or less regular rise in temperature for a comparatively long period of years. Also, that the prevailing condition was widespread, in fact apparently world-wide, and in addition that temperature data up through 1932, the terminal of the records presented in that paper, afforded no indication of an impending trend reversal to more normal thermal conditions in the then near future.

Up to the end of 1945 records for thirteen subsequent years have become available and these are here presented, supplementary to the original data, to determine tendencies since 1932. They show that the general upward temperature trend continued for several years but that the more recent records indicate a leveling off, and even contain currently a suggestion of an impending reversal.

The general temperature tendency since 1932 is illustrated by the following records: At Washington, District of Columbia, 70% of the 156 months, 70% of the winters, 85% of the springs, 100% of the summers, 92% of the falls, and 100% of the years (annual averages) have had above-normal temperature. For Chicago the above-normal percentages have been, for all months 71%, winter 77%, spring 69%, summer 92%, fall 85%, and for the year 100%. For the entire United States, 67% of the months, 70% of the winters, 54% of the springs, 70% of the summers and 62% of the falls have had above normal, while only 23% of the years have had below normal temperature. The accompanying graphs show that these data are representative of conditions in general.

The reference base "normal" wherever used in this discussion refers to the arithmetic average of all records included in the respective series. Incidentally, it might be mentioned that the normals here employed for these long-record stations usually differ from the

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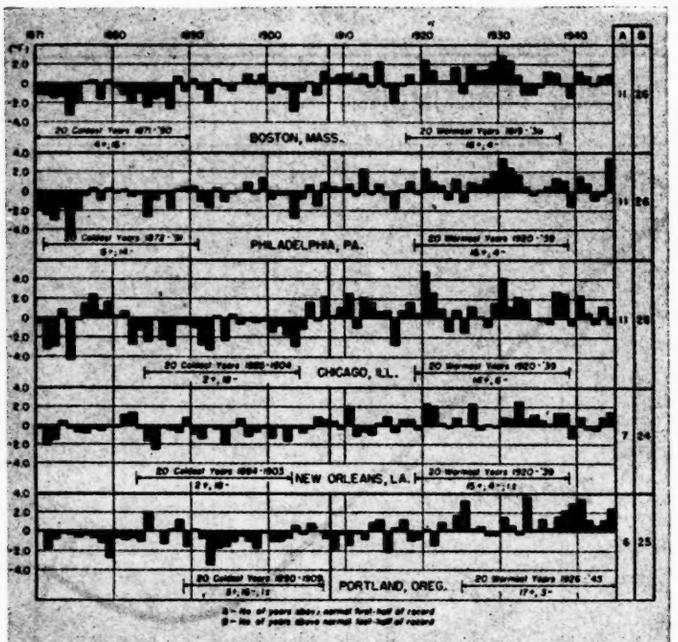


Fig. 1. Departures from normal of annual temperatures for five widely distributed cities from 1871 to 1945.

standard Weather Bureau normals by only a small fraction of a degree.

Fig. 1 shows for five widely-distributed Weather Bureau stations the year-by-year departures of the mean annual temperature from normal, 1871-1945, the arithmetical mean for the entire period being considered the normal. The stations are Boston, Philadelphia, Chicago, New Orleans, and Portland, Oreg. The records for Philadelphia and Portland begin with 1872. A mere glance at this chart shows that the last half of the period for all stations was characterized by a preponderance of positive anomalies and the first half by equally frequent and pronounced negative values.

Dominant features are common to all records, such as for Boston; the coldest consecutive 20 years comprised the period 1871-90, with only 4 above normal and 16 below normal, while the warmest, 1919-38, had 16 above normal and only 4 below. Each period contains more than 7000 consecutive days, and the temperature for the warmest averaged 2.3F per day higher than for the coldest. The first half of the record had only 11 years above normal, while the last half had 26 years above, or more than twice as many.

An examination of the other records discloses, with only minor variations, general conformity with those

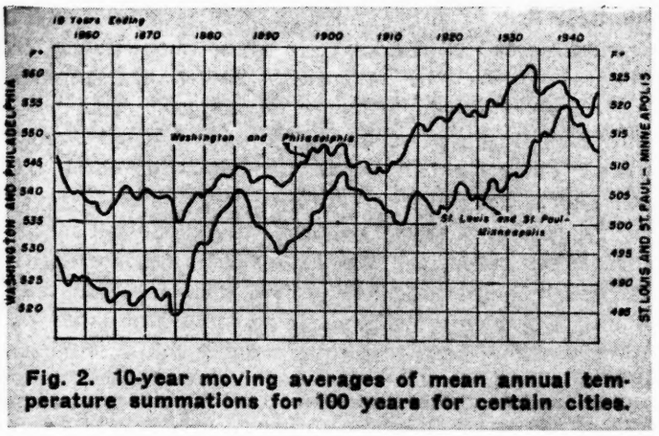


Fig. 2. 10-year moving averages of mean annual temperature summations for 100 years for certain cities.

for Boston. They show from approximately 2.5 to more than 4 times as many plus anomalies for the last half of the records as for the first half; in all cases the periods comprising the coldest 20 years fall in the first half, with a slight lag for the central and western stations, while the warmest double decade invariably falls in the latter part of the record. The average daily temperature excesses for the warmest periods over the coldest are: Philadelphia 2.0F, Chicago 2.5F, New Orleans 1.6F, and Portland 2.1F.

Temperature Trends

Long-time weather trends are shown most graphically by smoothing the records; otherwise the year-to-year, or short period, fluctuations tend to obscure any general trend that may be present. Fig. 2 to 8 were prepared by a device known as moving summations, or moving averages, where the entry under each date represents the sum, or the average, as the case may be, for the base period indicated up to and including the respective dates of entry. For example, in Fig. 2 the first entry under 1855 represents the sum of the mean annual temperatures for the 10 years, 1846-55; the second, the sum for 1847-56, and so on through the chart.

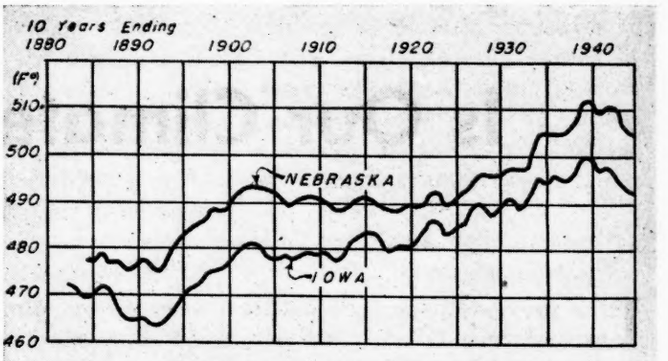


Fig. 3. 10-year moving averages of state-wide annual temperature summations for two rural states, showing that artificial heat is not responsible for the trends indicated in other graphs.

Fig. 2 shows for 100 years, by 10-year moving summations, the general temperature trends for an eastern and a midwestern area, the former represented by the average annual values for Washington, D. C., and Philadelphia, and the latter by similar data for St. Louis, and Minneapolis-St. Paul. The general conformity of the trends is apparent, with the coldest decade ending with 1875 or '76, and the warmest in the late 1930's. The amplitude of the 10-year averages (lowest to highest mean daily temperature for ten years) is 2.7F for the eastern area and 3.7F for the western. Up to about 1875 both areas show a temperature recession, and thereafter a general, though irregular, rise for some 60 years. However, the terminals contain a veiled suggestion of a pending recession, but at the same time this may prove to be temporary as shown for the 1900 decade.

It has been suggested that the warm trend, such as here shown, in temperature records for individual stations located in large cities may be more apparent than real because of urban, artificial influences that may

be brought about, through expansion and increase in activities, heating, etc., that would influence city-exposed thermometers, but not operative in the nearby open country. To test this, Fig. 3 and 4 were prepared. Fig. 3 contains 10-year summation trends for two midwest States, Iowa and Nebraska, in which all Weather Bureau stations within the respective States were included. Most of these records were made in small towns or the open country and only a few in large cities.

Here the trend lines are not only in agreement with each other, but they conform in general to the records for large cities as shown in Fig. 2. In both States a general trend rise began with the decade ending in 1892, with a leveling off from 1903 to 1920, to be succeeded by a pronounced rise for the following twenty years up to 1940. Since 1940 there has been a more pronounced suggestion of recession than is afforded by Fig. 2.

It is interesting to note that the amplitudes, on the basis of these State averages, are 3.7F in both cases, or exactly the same as shown for the St. Louis and St. Paul-Minneapolis trend in Fig. 2. That is to say, the temperature for the warmest ten years (approximately 3650 consecutive days) averaged 3.7F a day higher than for the coldest decade. A remarkable fea-

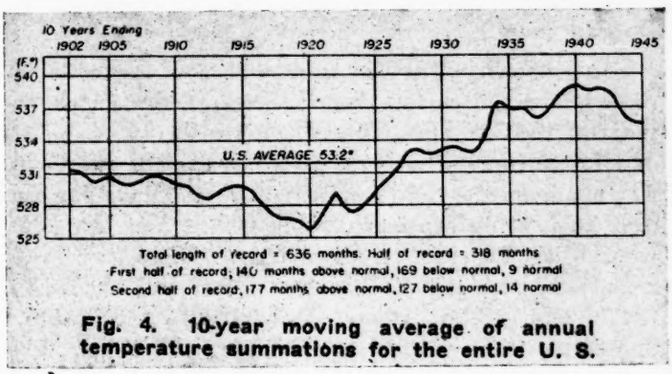

10 Years Ending
1902 1905 1910 1915 1920 1925 1930 1935 1940 1945
(F.°)
540
537
534
531
528
525
U.S. AVERAGE 53.2°
Total length of record = 636 months. Half of record = 318 months
First half of record; 140 months above normal, 169 below normal, 9 normal
Second half of record, 177 months above normal, 127 below normal, 14 normal

Fig. 4. 10-year moving average of annual temperature summations for the entire U. S.

ture of all graphs presented in this paper is the confirmatory evidence they offer through agreement among themselves, often down to small details, as shown for these two States.

To further expand the question of areal limitations on general temperature trends, Fig. 4 was prepared. This is based on the average temperature for the entire United States, embodying several thousand records, as determined by areally weighting State averages. Here the current warm temperature phase, on a decade basis, began during the ten years ending with 1921 and extended to 1940. Again we find for the last few years suggestion of an impending recession. This graph covers 53 years or 636 months. For the 318 months comprising the first half, 149 had normal or above normal temperature, while for the last half there were 191 such months. The first half had 169 months below normal and the last half only 127.

In Fig. 5 the record of annual temperature for the entire United States, shown in Fig. 4, has been broken down into seasons—winter, spring, summer and fall. It shows that the upward temperature trend has not been confined to any particular period of the year but is common to all seasons. However, the summer advance began first (for the decade ending with 1913)

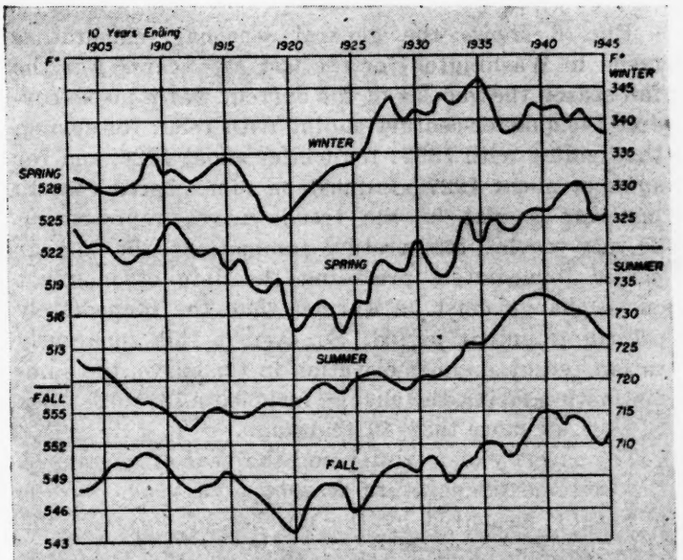


Fig. 5. 10-year moving summation of seasonal mean temperatures for the entire U. S.

and the other seasons soon fell into line. Here, again, we find in the latter part of the records some indication of a general reversal of trend for all seasons.

Outstanding Features of Recent Washington Weather

A more detailed examination of weather records for Washington, D. C., discloses that the current warm climatic phase here has very definitely brought about pronouncedly milder winters and much hotter summers than were experienced some half century or so ago. For example, for the last 25 years, on an annual basis, 1921-45, 22 have been warmer than normal, while for a similar period from 1855 to 1879 only 3 had above normal warmth. Twenty-five years have approximately 9000 consecutive days, and for the warmer period the temperature averaged 2° a day higher than for the colder. Again, during the last 25 years 20 winters, 18 springs, 20 summers and 22 falls have had excesses in temperature, against 7, 6, 10 and 11, respectively, for the 1855-79 quarter of a century.

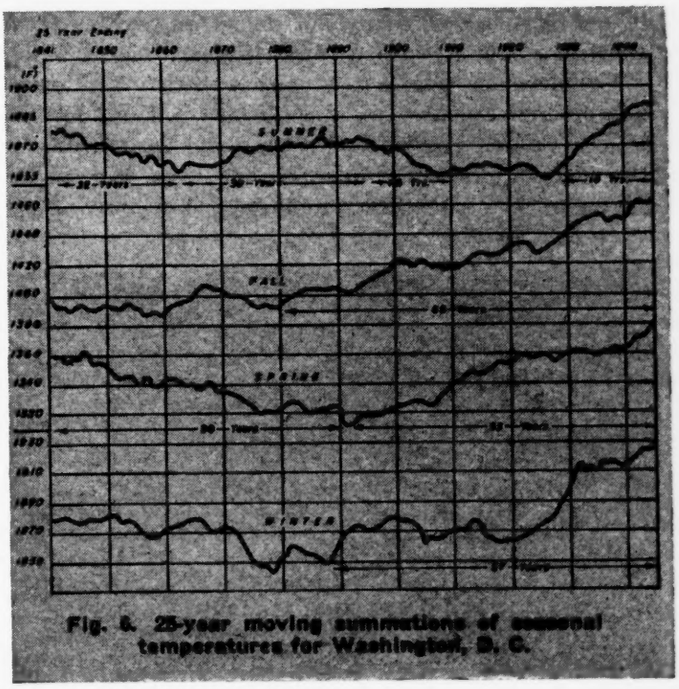


Fig. 6. 25-year moving summations of seasonal temperatures for Washington, D. C.

Fig. 6 shows the general seasonal temperature trend in Washington for the last 129 years. For the fall season the genesis of the current warm phase covered the quarter-century ending with 1880; for spring, that ending with 1892; for winter about 1920, and for summer about 1927. It must be remembered that to instigate a rise in the trend curves representing 25-year moving temperature summations, the 25-year period immediately preceding the date of incipient curve change must be warmer than the immediately preceding similar period. So, even in this apparently rather recent summer elevation in the curve, the summation producing the change included all records back to 1902, or more than 40 years ago.

The severity of a winter and the heat of a summer, the extreme temperature seasons of a year, may be physically measured by the number of severely cold days and the number of extremely hot days, respectively. While a reasonable specific definition of a severely cold day and an extremely hot day would not hold generally for areas of marked differences in climate, in Washington experience dictates that a day on which the temperature remains continuously below freezing is considered by the man in the street as a severely cold day, and one on which the temperature rises to 90F or higher as an outstandingly hot one. We have considered that the number of such respective days afford a reasonable yardstick to measure the abnormalities of the respective seasons and for comparing one year with another.

Fig. 7 indicates the general trends of the number of such days (both cold and hot) in Washington for the 74 years, 1871-1945. It shows that the average number of cold winter days for the 20 winters, 1871-1890, was 17 per year, while the average for the last 20 years has been only 11. The trend to hotter summers has even been more pronounced than to milder winters. In this case we find for the 20 years, 1888-1907, that the average number of hot days per year was only 19, while for the last 20 years, up to 1945, the average has been 34 per year. So during the last 20 years in Washington there has been an average of nearly twice as many hot days per year as there were in a similar period some 40 years ago.

Furthermore, Fig. 8 tells us that the average lowest winter temperature for Washington for the decade 1898-1907 was approximately 2F above zero, while for the last 10 years the average has been 11F above. These records show very definitely that the current

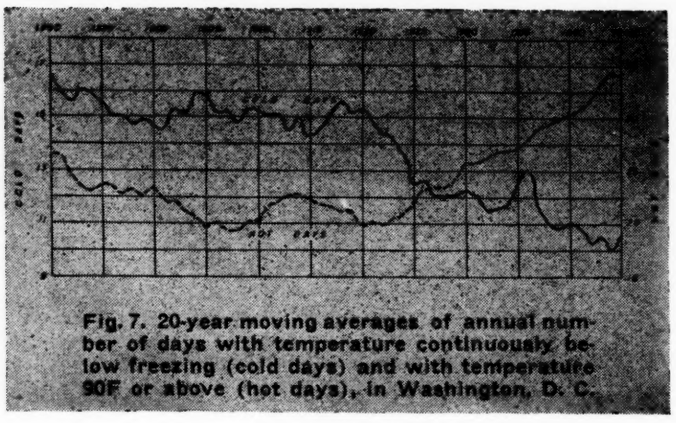


Fig. 7. 20-year moving averages of annual number of days with temperature continuously below freezing (cold days) and with temperature 90F or above (hot days), in Washington, D. C.

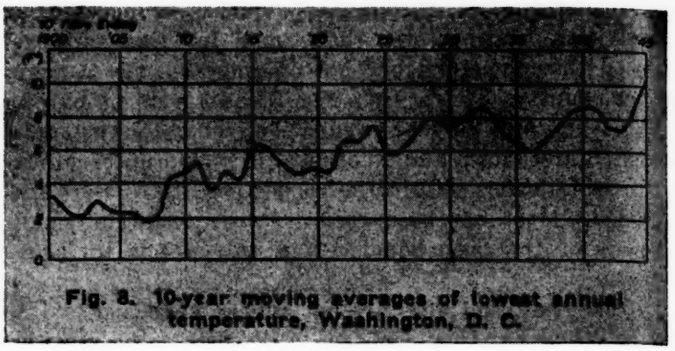


Fig. 8. 10-year moving averages of lowest annual temperature, Washington, D. C.

warm phase of climate has brought to Washington (and similar conditions are widespread) decidedly milder winters and much hotter summers than were experienced in bygone days. This does not connote, of course, that every winter may be expected to be mild and every summer hot until the temperature has definitely receded, but it does mean that until then the chances are largely in favor of such conditions. As previously indicated, the terminal of the trend lines here presented does not offer a suggestion of the eve of a reversal of trend, but the length of that part of the records offering such suggestion is yet too short to predict with confidence.

Degree Days

Examination of the season-by-season degree days records for the period from the season of 1898-99 to that of 1944-45 also reflects the recent warm phase of climate in relation to the cold season of the year. For example, the total number of degree days for the first 20 heating seasons of this period and the total for the last 20 seasons, up to that of 1944-45 for selected stations are as follows: Bismarck, N. Dak., 184736 and 173473; Albany, N. Y., 135222 and 131616; Columbus, Ohio, 114037 and 107601; St. Louis, Mo., 95013 and 90819; Ft. Worth, Tex., 48037 and 46078; Memphis, Tenn., 62881 and 59852; Atlanta, Ga., 62176 and 58798.

Thus, it will be seen that, in most cases, the difference between these totals amounts to approximately the seasonal normal, or the number that would occur in one normal season. As in the case of temperature for the entire year, the more recent degree day records, say since about 1940, contain a suggestion of a reversal of trend impending, to lower temperatures and greater degree day units, for a future undetermined period of years, but, as in the case of general temperature conditions through the year, it is too early to predict this with a high degree of confidence.

Temperature and Forecasting

While temperature trends as here developed do not provide a tool for definite and specific long-range weather forecasts, they are valuable in affording an indication of expectancies or probabilities of future weather beyond the range of standard synoptic forecasting. Limitations are imposed, of course, by the lack of advance knowledge as to when a prevailing trend may go into reverse, but at the same time the fact is definitely established that once prevalent these trends are of comparatively long tenure.

Space Heating by Electricity

W. G. DAVIES

Chief Power Sales Engineer,
Electric Power Board of Chattanooga

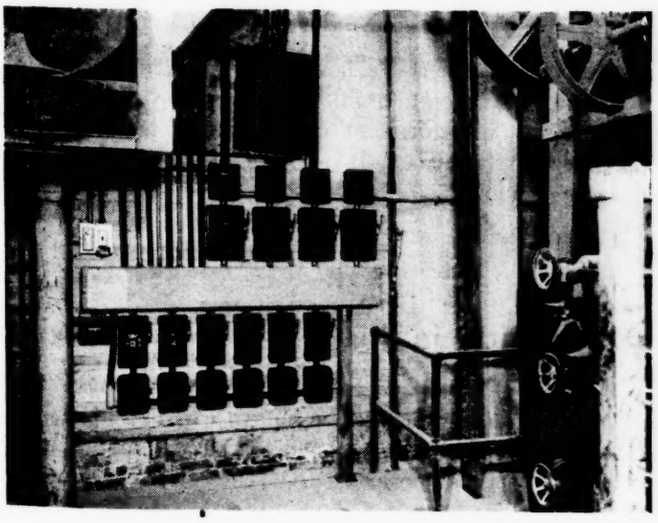
Case studies of some commercial and industrial heating installations using electricity in Chattanooga, Tenn. Monthly power consumption is tabulated together with degree day data and space conditions.

HEATING by electricity has proven feasible under low TVA rates in Chattanooga, Tenn., and other parts of the Tennessee Valley.

Labor saving has become quite an item in heating costs for industries and stores as the 40 hour week and minimum wage have increased the cost of firemen and coal handlers. The increased price of coal, almost 100% increase in steam coal, has also has its effect.

In Chattanooga, a growing number of industries and small stores are installing electric heat. One ladies' ready-to-wear store which has a volume of 33,000 cu ft and which is very well protected by adjacent buildings, installed two 20 kw blower type heaters in 1935. It has just completed its tenth year of electric heating and air conditioning, both of which have been very satisfactory. With the low heat loss of this building, it has been heated with from 18,000 to 20,000 kwh each heating season.

The largest electric space heating load in the Tennessee area is a flour mill which made a complete change from an obsolete steam boiler heating installation to electric blower type heaters in September, 1945. The installation has just completed its first successful season.



D sconnect switches and thermostatically controlled contactors installed in a flour mill. Controls were banked for simplification.

Electrically heated shoe store reports a labor saving over previous heating system.

While from the first it was planned to take advantage of off-peak operation and to keep the mill at 65F to 68F at night, it was found that this idea worked surprisingly well. In other words, it was found that the 655 kw connected load in heaters could be operated a large percent of the time off the peak of the 900 kw demand of the mill's productive equipment.

The heated space is 598,650 cu ft. The connected load of 655.5 kw is supplied through 50 units, 7½ to 20 kw each. The main mill has five floors, insulated ceiling, and tight fitting windows and doors.

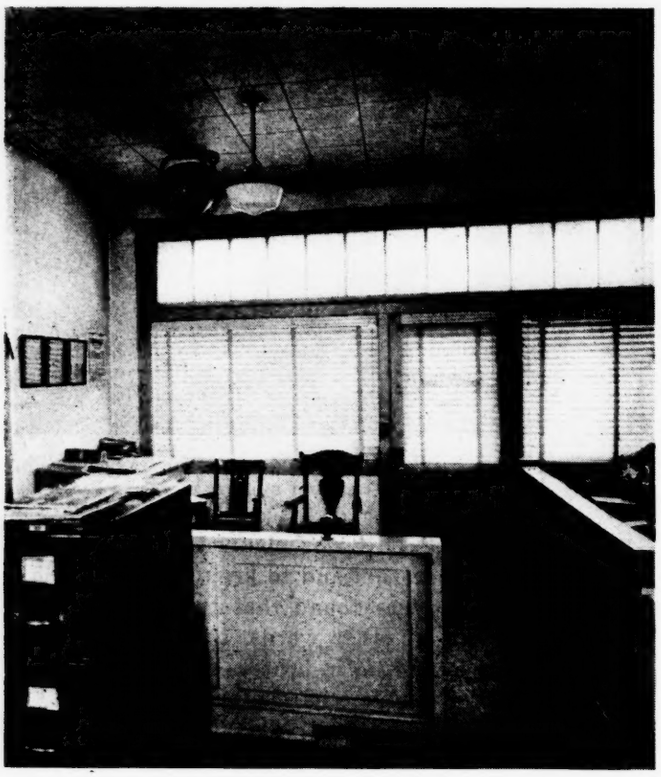
Record of Season's Operation at the Mill

Month	On-Peak Demand	KWH	Degree Days
1945			
Oct.	57	40,000	197
Nov.	100	60,000	411
Dec.	420	140,000	907
1946			
Jan.	115	125,000	719
Feb.	150	110,000	567
Mar.	0	60,000	230
Apr.	0	40,000	171
Total		575,000	3203

This same idea of off-peak use has been adopted in a number of plants which have steam plants for factory heating but have found economy in putting an electric heating installation in the office for use Saturday and Sunday while the plant is not operating. Electric heat

Typical Installation Data

Installation	Cubic Content, Cu Ft	Ceiling Height, Ft	No. of Unit Heaters	Total Installed Capacity, Kw	Power Consumed, KWH								KWH per Cu Ft per Season
					1945		1946					Season Total	
					Nov	Dec	Jan	Feb	Mar	Apr	May		
Shoe Store	7,700	11	2	20	500	2,400	2,770	2,050	1,650	190		9,560	1.24
Hosiery Mill	52,800	11	6	80	8,770	22,790	21,160	25,640	11,480	6,120		97,960	1.85
Hosiery Mill	33,600	12	4	35	2,270	10,605	12,300	14,535	7,845	2,490	1,500	15,545	1.53
Display Room	7,500	12	3	20	210	1,920	2,970	3,690	1,350	270		10,410	1.38
Utility Office	21,125	13		25	720	3,040	4,360	5,480	3,360	1,080	880	18,920	.89
Contractor's Office	7,348	11	3	10½	450	2,010	2,480	2,250	1,070	180		8,440	1.14



General contractor's office heated entirely by electric unit heaters.

thus used is entirely off-peak and on the low steps of the kwh rate.

Each installation should be calculated as to exposure and heat loss. It has been the policy to recommend against electric heat unless the area to be heated has, (1) insulated ceilngs (4 in. rock wool recommended), (2) tight side walls, and (3) weather stripped doors and windows.

When these conditions are met and there are no excessive exposures, it has been found that one to two watts per cubic foot of building volume will be the capacity usually installed.

By compiling data from a number of varied installations it has been found that operation in the Chattanooga area (3,200 degree days) will use from 1 kwh to 2 kwh per cu ft per heating season. This is, of course, based on the user observing the precautions mentioned.

On this basis, electric space heating has a very definite place to fill in the commercial and industrial economy. Quality of available equipment, automatic operation, absence of flame and products of combustion, safety, cleanliness, and overall economy, have placed electric space heating in a position to render definite service. The mere comparison of Btu's per unit of purchase is not a true measure of what the user wants or buys.

Electric space heating has arrived in Tennessee, in industrial and commercial buildings as well as in residences. This does not mean that it is advocated for every installation. It is not. However, there is an ever growing number of places where it can be used.

Monthly Degree Days in Chattanooga, Season 1945-46

Oct.	197	Jan.	719
Nov.	411	Feb.	567
Dec.	907	Mar.	230
		Apr.	171
Normal	3190	Total	3203

Measurement of Carbon Monoxide in Air

A method for the accurate determination of the carbon monoxide in air is contained in a 111-page report by the Department of Commerce.

Red mercuric oxide is employed so that the carbon monoxide reacts with it to form carbon dioxide gas and mercury vapor. The amount of CO present can then be determined by measuring the weight loss in the chemical reaction or by a special instrument.

The instrument uses calibrated test papers which contain selenium sulfide. The length of the blackening produced on this test strip, when exposed to mercury vapor liberated through the CO reaction with the red mercuric oxide, is indicative of the CO concentration in air. Measurements can be made over a range of zero to 3% with an accuracy of 5-10%. About three minutes is required to complete the test.

HEATING AND VENTILATING'S *Reference Section*

Thermodynamics for the Air Conditioning Engineer

Part 1: Basic Principles

By E. P. Palmatier, Carrier Corporation, Syracuse, N. Y.

Thermodynamics for the Air Conditioning Engineer

E. P. PALMATIER
Carrier Corporation, Syracuse, N. Y.

Part 1: Basic Principles

The subject of thermodynamics as it applies to air conditioning engineering is covered in two sections. Part 1 covers basic principles; Part 2, on applications and psychrometry, to follow. Subjects covered in Part 1 include equivalence of various types of mechanical energy; meaning of internal energy and its relation to work and heat; the fact that specific heat depends on the type of process involved; meaning of enthalpy; important characteristics of ideal gases; mixture of ideal gases; and reversibility.

THERMODYNAMICS is a very extensive science. It is used by the chemist, physicist, astronomer, metallurgist, meteorologist, and even by the biologist. The engineer employs an abridged form of the subject, usually called engineering thermodynamics. It is this form which is of interest to the air conditioning engineer.

By way of definition, it may be said that engineering thermodynamics deals primarily with thermal and mechanical energy (two of several categories) and with their relation to the properties of engineering materials. As a starting point, let us consider the subject of energy.

ENERGY

The energy concepts about to be developed are an oversimplification of modern physical theory. It is now clear, because of atomic bomb research, that matter and energy are in fact exchangeable. Huge amounts of energy can be developed in a system where none existed before. At the same time, a measurable amount of matter disappears. The conversion factor is the velocity of light squared.

These things that have so recently come to pass completely undermine simple thermodynamic theory if one elects to be rigorous about the subject. Unless they are ignored, this discussion would necessarily have to be elevated to a plane above your author's level of understanding. So we shall say that, excepting nuclear reactions, matter and energy are distinct and separate things, each indestructible.

But there are several primary forms of energy as: Chemical, electromagnetic, mechanical, and thermal. We shall only consider the last two after making the statement that the chemical energy associated with such reactions as combustion, fermentation, etc., must be recognized by the air conditioning engineer and engineering thermodynamicist as common sources of thermal energy.

Mechanical energy may be classified under three subheadings:

1. *Work*, which is the basic form and which is the product of (a), force $\times$ distance (F $\times$ L) or (b), torque $Y \times$ angle of twist a in radians (Y $\times$ a).

2. *Potential energy*, which is stored work in the form of (a), stress in elastic bodies such as in springs, etc., or (b), a difference in elevation, Z, as in the case of water impounded by a dam.

3. *Kinetic energy*, which is energy of motion possessed by a mass. Kinetic energy may be linear, in which case it is one-half the product of the mass times velocity squared, $\frac{MV^2}{2}$, or rotative, where it is half the moment of inertia (I) times angular velocity (N) in radians squared, $\frac{IN^2}{2}$.

Thermal energy is not very easily defined. According to the generally accepted theory, it is stored energy associated with the velocity, vibration, and rotation of the atoms and molecules of a material and evidenced by the relative hotness or coldness of the material. It has the peculiar and practically irresistible tendency to flow from hot to colder bodies. Unassisted flow of thermal energy in the reverse direction, from cold to hot, has never been observed.

Fig. 1 shows physical examples of three forms of mechanical energy and illustrates the transmission of thermal energy from one body (chunk of material) to another. It also illustrates a conversion of mechanical energy into heat or thermal energy.

Internal Energy

It is a common experience that under constant pressure, such as atmospheric pressure, the volume of materials change as they are changed in temperature. This volume usually increases with increasing temperature as in the case of air. But nature plays funny tricks. Water, for example, when heated from freezing to about 39F decreases in volume.

Referring to Fig. 2, suppose one pound of some material is placed in a cylindrical container whose cross-section area is A. The volume of one pound of material is called its *specific volume*. Then $v = A \times L$. The pressure p on the material is maintained constant

by means of the weight F and the piston is assumed to be weightless and frictionless. $F = p \times A$.

What happens if a small amount of thermal energy dQ is added to the material? First, its temperature will rise by the small amount, dT. If its volume expands, the weight will be lifted by the amount

$$dL = \frac{dv}{A}$$

and work will be done in the amount

$$dW = F \times dL = pA \times \frac{dv}{A} = pdv$$

If contraction occurs, the work done on the weight is negative since dL and dv are negative. The weight gives up mechanical energy to the material. Obviously, the weighted piston could be replaced by the force exerted by atmospheric pressure or any other constant pressure surrounding the material, and the mechanical work done or received would still be represented by

$$dW = pdv$$

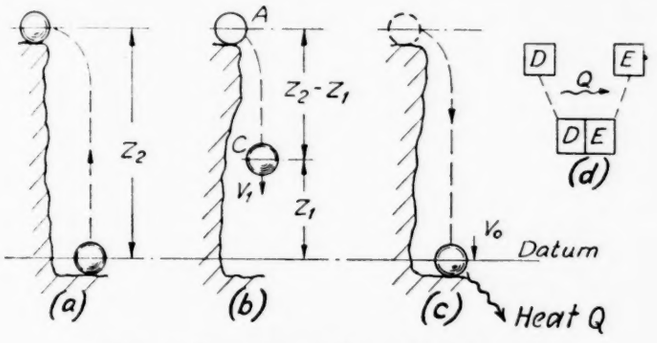


Fig. 1. Examples of Mechanical Energy

(a). Iron ball weighing 1 lb if lifted to height Z_2 by *work* ($1 \times Z_2$) has a greater *potential energy* by the amount of the force, 1 lb, times the distance Z_2.

(b). The ball rolls off and falls freely from A to C, acquiring *kinetic energy*.

$$Z_2 - Z_1 = \frac{1}{2g} V_1^2$$

(c). When it strikes the ground, the kinetic energy $Z_2 = \frac{1}{2g} V_0^2$ is converted to *thermal energy* Q in the ball and ground.

(d). The two bodies D and E are at different temperatures. If brought in contact, *thermal energy* Q is said to be transferred from D to E until they reach a common temperature. D loses energy and gets cooler; E gains energy and gets hotter.

The important conclusion to be derived from this example is:

When thermal energy is transferred to any material under pressure p and the volume changes by the amount dv, mechanical energy is unavoidably given up to its surroundings in the amount pdv.

Since many materials are available which expand when heat is added, a way has been found to produce *mechanical energy from thermal energy* — a very important discovery on which practically all power generation is based. But if the mechanical energy produced is compared with the thermal energy input, by means which will be described later, it will be found to be only a small fraction of the latter. The difference $dQ - dW$ must be stored in the material and be the cause of its temperature rise, dT.

As a check of this premise, suppose the piston in Fig. 2 were locked at the original height L and sufficient heat energy dQ' is added to produce the same temperature rise as before, dT. Obviously, since the piston cannot move, no work can be done and $dW = 0$. Comparison of dQ' with the difference $dQ - dW$ will reveal that they are, in the case of most substances, practically identical.

The energy $dQ - dW = dQ'$ is called *internal energy, du*, and resides, as explained in the definition of thermal energy, in the form of molecular activity. Thus, for the two cases described, when v changes,

$$dQ - dW = dQ - pdv = du \qquad (1)$$

and when v is constant

$$dQ' = du \qquad (2)$$

Specific Heat

There are several ways of defining specific heat by relating the heat added to materials to that added, under certain conditions, to the most common of substances, water. We shall select a less complicated and more general definition as follows:

Specific heat (C) is the thermal energy necessary to be added to a pound of material to raise its temperature one degree.

This definition, mathematically expressed, is simply

$$C = \frac{dQ}{dT} \text{ or } dQ = CdT \qquad (3)$$

It has been noted that for a constant volume process (Equation 2)

$$dQ' = du$$

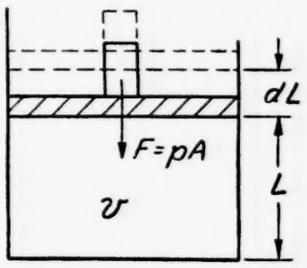


Fig. 2.

Therefore, the *constant volume specific heat* of a substance

$$C_v = \frac{dQ'}{dT} = \frac{du}{dT} \text{ and } du = C_v dT \qquad (4)$$

For a constant pressure process, the *constant pressure specific heat* (Equation 1)

$$C_p = \frac{dQ}{dT} = \frac{du + pdv}{dT} = C_v - p\frac{dv}{dT} \qquad (5)$$

Examination of (4) and (5) shows that C_p cannot

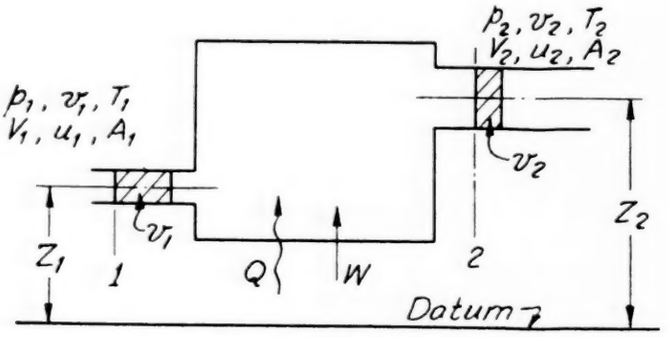


Fig. 3.

equal C_v unless $p = 0$ or $\frac{dv}{dT} = 0$. Although both these circumstances are possible, $p\frac{dv}{dT}$ can be either positive or negative and C_p either greater or less than C_v.

For a pound of water boiling or condensing at constant pressure, dQ may be $\pm$ 1000 heat units and the change in temperature $dT = 0$. Then,

$$C_p = \frac{\pm 1000}{0} = \pm \infty$$

We shall see that it is possible, in certain circumstances, to extract mechanical energy from a material and change its temperature with no exchange of thermal energy or heat. Then $dQ = 0$ and

$$C = \frac{0}{dT} = 0$$

It is also possible to extract so much mechanical energy from a material that its temperature will drop one degree in spite of the addition of 10 heat units. Then,

$$C = \frac{10}{-1} = -10$$

By this, it is clear that specific heat can have any value from $+\infty$ to $-\infty$, depending on the process to which the material is subjected.

Mechanical Equivalent of Heat

Thus far, no units have been applied specifically either to mechanical energy or thermal energy. The unit of mechanical energy was implied by the definition of work. If force is measured in pounds and distance in feet, the unit of work is obviously pounds $\times$ feet or foot pounds. Since, by the equations of mechanics, the other forms of mechanical energy (potential and kinetic) can be represented by the product of force and distance, the unit for expressing all mechanical energy is the foot pound.

It is not so simple to define a unit for thermal energy. Attempts have been made to relate the unit to the quantity of heat necessary to increase the temperature of pure water one degree under certain specified conditions. Practical difficulties encountered in the experimental determination of such a heat quantity have started a movement to define arbitrarily the unit of thermal energy in terms of the unit of mechanical energy. Consequently, the English unit of thermal energy, called the British thermal unit or Btu, will be defined as 778 foot pounds.

The figure 778 will be designated by the symbol J and is called the *mechanical equivalent of heat.* The Btu thus defined is approximately equal to 1/180 of the amount of heat necessary to raise one pound of pure water from the freezing temperature to the boiling temperature at standard atmospheric pressure.

Example (1) – Energy and Specific Heat

(1) One pound of dry air at 17F and 14.7 lb per sq in. absolute has a volume of 12 cu ft. If it takes 12 Btu to heat it to 67F, at constant pressure, what is C_p?

$$C_p = \frac{12}{67 - 17} = \frac{12}{50} = 0.240$$

If the volume at 67F is 13.27 cu ft, what would one expect C_v and C_p/C_v to be?

Work done $= pdv = p\ (v_2 - v_1)$

$= 14.7 \times 144\ (13.27 - 12) = 2{,}688$ ft lb

$$\text{Heat equivalent of work done} = \frac{2688}{778} = 3.455 \text{ Btu}$$

$$du = dQ - dW = 12 - 3.455 = 8.545$$

$$C_v = \frac{du}{dT} = \frac{8.545}{50} = 0.1709$$

$$C_p/C_v = 0.240/0.1709 = 1.404$$

First Law of Thermodynamics

It has already been stated that the nearly exact assumption that matter and energy are indestructible will be made. These two related concepts have been called *The Conservation of Mass* and *Conservation of Energy* principles.

The *first Law of thermodynamics* is really a form of the latter principle and has already been substantially developed for materials in a static condition by the process represented by Fig. 2 and equation (1). It was noted that when heat was added to a material and external work was done, the difference $dQ - dW$ remained in the material in the form of internal energy, du. It was also noted that dW might be positive or negative. The process might be carried out in the reverse direction so dQ could be positive or negative. In any case, if no energy is lost, and heat and work terms are considered positive if the energy is *added to* the material,

$$dQ + dW = du$$

Since the units of heat and work are convertible by the factor $J = 778$, this equation assumes dW and dQ are in the same units.

The sum of the heat added and work done on a ma-

terial at rest or in uniform horizontal motion is equal to its change of internal energy.

This is a statement of one form of the first law of thermodynamics. A second, more useful form applying to flow processes will now be developed.

Steady Flow Equation and Enthalpy

Suppose an elastic material like air is flowing through an apparatus as indicated in Fig. 3.

It enters with pressure, p_1, specific volume, v_1, temperature, T_1, velocity, V_1, internal energy, u_1 and at elevation Z_1. The total of all work and heat increments added *per pound* between the entrance section 1 and the exit 2 are W and Q, respectively. The fluid leaves with properties p_2, v_2, T_2, and u_2, and at velocity V_2 and elevation Z_2. Presumably, no material or energy is stored in the apparatus so for each pound entering, a pound of fluid leaves. By the conservation of energy, the sum of all energy elements entering the apparatus must equal the total energy leaving the apparatus.

In addition to the entering elements of energy, dQ and dW, energy is transported into the space as internal energy of the fluid in the amount, u_1, energy units per pound. Also, kinetic energy enters the apparatus with each pound in the amount $\frac{V_1^2}{2g}$. Potential energy Z_1 enters with each pound. Finally (here one must pay close attention), an amount of mechanical energy is added at the entrance, to the material within the apparatus, equal to the product p_1v_1. In explanation, consider the 1 lb of volume v_1 entering through area A_1 to be contained between two plane surfaces as indicated. The fluid following it is pushing with a force $p_1 \times A_1$ and must push a distance $\frac{v_1}{A}$ to get the pound through the section 1. The mechanical work done by the following stream is

$$p_1A_1 \times \frac{v_1}{A_1} = p_1v_1$$

While this is going on, one pound is leaving at 2 and the material inside the apparatus is likewise doing mechanical work on the leaving stream (which has left the apparatus) in the amount p_2v_2. Having considered all pertinent energy terms, an equation may be written indicating the essential equality of the energy per pound of material entering and leaving the apparatus as follows:

$$W + Q + \frac{V_1^2}{2g} + u_1 + p_1v_1 = \frac{V_2^2}{2g} + u_2 + p_2v_2 \quad (6)$$

It is interesting to note that if volume and temperature remain constant, i.e., $u_2 = u_1$ and $v_1 = v_2 = \frac{1}{s}$ (s = density, lb per cu ft) and if no external heat or work is added ($dW = dQ = 0$), equation (9) becomes

$$\frac{V_2^2 - V_1^2}{2g} + (Z_2 - Z_1) + \frac{p_2 - p_1}{s} = 0 \quad (7)$$

which may be recognized as Bernoulli's equation of hydraulics.

Equation (6) can be simplified by the definition of a new property of the material called *enthalpy*

$$h = u + pv \quad (8)$$

Remember, this is a *defined property* only justified by the fact that in steady flow problems u and pv always occur together and in some processes their sum remains constant. Rewriting and rearranging (6) in terms of enthalpy

$$W + Q = \frac{V_2^2 - V_1^2}{2g} + (Z_2 - Z_1) + (h_2 - h_1) \quad (9)$$

This is another expression of the first law applying to flow processes and states that—

The work plus heat added equals the sum of the increases in kinetic energy, potential energy and the newly defined property, enthalpy.

Equation (9) is usually called the *Steady Flow Equation.* It should be remembered that for flow processes, enthalpy (h) is an important property. However, if a fixed quantity of material is being studied in a container or in a relatively static condition, the work and heat added affects its internal energy (u) and enthalpy is usually of no importance.

THE IDEAL GAS

All materials exist at ordinary atmospheric temperatures and pressures in three primary forms or phases, namely, solid, liquid, and gas. The student of hydraulics concerns himself with the properties and characteristics of stationary and moving fluids. To simplify his reasoning, he makes certain justifiable assumptions; for example, that the densities of liquids are independent of pressure. After understanding the idealized problem, he investigates the way in which real materials deviate from the ideal and the effects of deviations in practical problems.

In thermodynamics, a similar method of approach is used. It has already been noted how the change of temperature and specific volume of compressible ma-

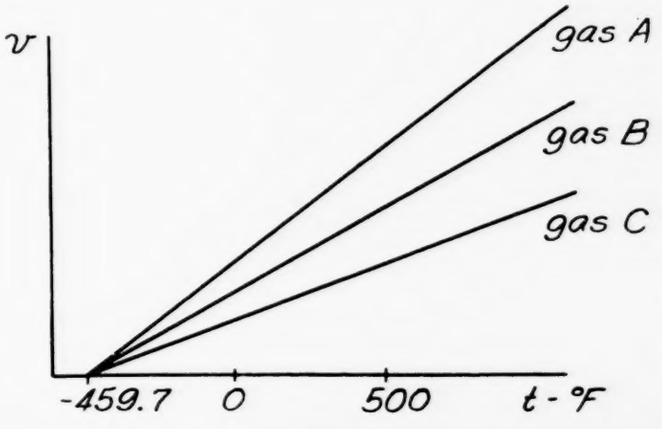


Fig. 4.

terials like air are related to the transformation of thermal energy into mechanical energy or work. The compressible fluid is, therefore, of great interest in the study of thermodynamics.

It can easily be demonstrated experimentally that certain simple gases like oxygen, nitrogen, air, etc., behave, almost exactly, in accordance with two laws which define, in part, the properties of an ideal gas. Consequently they are often referred to as *ideal gas laws.*

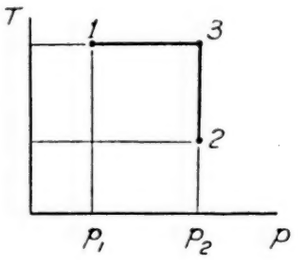


Fig. 5.

(a) *Boyle's Law*—At constant temperature, the specific volume of an ideal gas is inversely proportional to the absolute pressure it supports.

(b) *Charles' Law*—At constant pressure, the change of volume of an ideal gas is proportional to its change in temperature.

The strange thing about Charles' Law is that although different gases have different specific volumes at any given pressure and temperature, they all behave as if their volume would be zero at a temperature of —459.7F (See Fig. 4.)

Charles' law can be restated, then, in the form: At constant pressure, the volume of an ideal gas is proportional to temperature provided the zero of the temperature scale is taken at —459.7F.

This temperature scale (t + 459.7F) = T is called the *absolute temperature* or *Rankine scale* and is indicated by °R. Thus, 100F is 100 + 459.7 = 559.7 R.

Boyle's and Charles' laws enable the development of a single equation expressing the relation between the three fundamental properties of an ideal gas, absolute pressure (p in lb per sq ft), absolute temperature (T in °R) and specific volume (V in cu ft per lb). Referring to Fig. 5, let points 1 and 2 represent any two conditions of an ideal gas for which p, v and T are known. A third condition, 3, may be selected so that $p_3 = p_2$ and $T_3 = T_1$. Then, from Boyle's law

$$\frac{v_1}{v_3} = \frac{p_3}{p_1} = \frac{p_2}{p_1} \text{ so } v_3 = v_1 \frac{p_1}{p_2} \qquad (10)$$

From Charles' Law

$$\frac{v_3}{v_2} = \frac{T_3}{T_2} = \frac{T_1}{T_2} \text{ so } v_3 = v_2 \frac{T_1}{T_2} \qquad (11)$$

Since the specific volume v_3 can only have one value, from (10) and (11)

$$v_1 \frac{p_1}{p_2} = v_2 \frac{T_1}{T_2} \text{ and } \frac{p_1 v_1}{T_1} = \frac{p_2 v_2}{T_2}$$

But the states 1 and 2 were selected at random. So it must be concluded that all conditions of existence of an ideal gas are represented by the single equation of state—

$$\frac{pv}{T} = \text{constant} = R \qquad (12)$$

$$\text{or } pv = RT$$

All actual gases closely conform to the ideal gas equation of state at low pressures and certain (generally elevated) temperature ranges. Calculation of the gas constant, R, for different gases reveals that, approximately

$$R = \frac{1545.3}{M} \qquad (13)$$

where M = molecular weight.

Actual gases which approximate adherence to the pv = RT relation, display other important characteristics which justify a third specification for an ideal gas as follows:

The constant volume and constant pressure specific heats of an ideal gas depend only on temperature.

From the five relations

$pv = RT$

$C_v = f(T)$, meaning C_v is a function of T

$C_p = f(T)$

$du = C_v dT$

$h = u + pv$

the following conclusions may be derived:

1. Even though C_v and C_p may both vary with temperature, their difference remains constant and equal to $\frac{R}{J}$.

$$C_p - C_v = \frac{R}{J} \qquad (14)$$

2. For an ideal gas an increment of enthalpy, *dh*, equals $C_p dT$.

$$dh = du + pdv + vdp = C_p dT \qquad (15)$$

3. If C_p and C_v are each assumed to be constant (for actual gases approaching the ideal, C_p and C_v change very little in the range of temperature —100F to + 200F) and if the ratio $C_p/C_v = k$, two more equations may be developed:

$$\triangle u = \frac{R}{k-1}(T_2 - T_1) = \frac{1}{k-1}(p_2 v_2 - p_1 v_1) \qquad (16)$$

$$\triangle h = \frac{Rk}{k-1}(T_2 - T_1) = \frac{k}{k-1}(p_2 v_2 - p_1 v_1) \qquad (17)$$

REVERSIBILITY AND AVAILABILITY CONCEPT

Imagine an ideal gas with C_p and C_v constant to be contained in a cylinder as in Fig. 2. If the gas is compressed to a higher pressure along the rising pressure curve 1-2 (See Fig. 6) and no heat is allowed to flow in or out of the gas, the process is called an

adiabatic compression. "Adiabatic" means no heat transfer. If none of the work done goes to produce turbulence or disordered motion in the gas or is used to overcome friction, each increment of work $dW = -pdv$, and the total work done is represented by the area under the curve 1-2.

But from the first law of thermodynamics and the definition of internal energy,

$dW + dQ = du$, $dQ = 0$, $dW = -pdv$, $du = -pdv$

Under the conditions specified, each increment of work done on the gas increases its internal energy by an equivalent amount. If the compression process is reversed, each increment of work released in expansion is identical to that used for compression and results in a corresponding decrease in the internal energy of the gas. Such a process is said to be thermodynamically reversible.

As a general definition, a thermodynamically reversible process is one which, when reversed, will return the working substance and all other substances associated with the process to their original condition with no net change in the amounts of thermal or mechanical energy originally possessed by the working substance and surrounding bodies.

The reversible gas compression just described is analogous to the mechanical reversible processes of compressing a perfect spring or lifting a weight to a higher level. In these mechanical processes, if idealized, all the work added can be recovered by reversing the process. Hence, when any reversible process is performed which involves the application of mechanical energy, this energy is just as available at the end of the process as before it was used.

It can be shown that for a reversible adiabatic compression of an ideal gas with C_p and C_v constant, the compression curve is defined by the equation

$$pv^k = \text{constant} \tag{18}$$

The compression work is the area under the curve 1-2 of Fig. 6 and may be derived from (16) and (18)

$$W = u_2 - u_1 = \frac{1}{k-1} p_1 v_1 \left[\left(\frac{p_2}{p_1} \right)^{\frac{k-1}{k}} - 1 \right]$$

$$= \frac{1}{k-1} p_2 v_2 \left[1 - \left(\frac{p_1}{p_2} \right)^{\frac{k-1}{k}} \right] \tag{19}$$

If the work is done adiabatically and reversibly in a steady flow process described by equation (9), $Q = 0$

$$W + \frac{V_2^2}{2g} - \frac{V_1^2}{2g} = h_2 - h_1 = \frac{k}{k-1} p_1 v_1$$

$$\left[\left(\frac{p_2}{p_1} \right)^{\frac{k-1}{k}} - 1 \right] = \frac{k}{k-1} p_2 v_2 \left[1 - \left(\frac{p_1}{p_2} \right)^{\frac{k-1}{k}} \right] \tag{20}$$

Equation (20) results from (17) and (18) and is represented by the area behind the curve 1-2 in Fig. 6.

To complete the list of important ideal gas equations, the "polytropic" compression process must be described. Suppose instead of the heat transfer being zero during compression, as in the reversible adiabatic process, heat is added at such a rate that

$$\frac{dQ}{dW} = \text{constant} = \frac{n-k}{k-1} \tag{21}$$

Where n is the exponent of the compression curve on the p — v diagram as indicated by equation (22).

If $n > k$, dQ is positive during compression and the

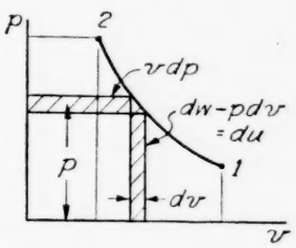


Fig. 6.

curve will lie above the reversible adiabatic, $pv^k = \text{constant}$, and will have the equation

$$pv^n = \text{constant} \tag{22}$$

Other possibilities are:

(b) Compression, $n < k$, heat extracted, work added
Expansion, $n > k$, heat extracted, work released
Expansion, $n < k$, heat added, work released

The compression work, assuming, as before, no internal turbulence, etc., may be shown to be

$$W = \frac{1}{n-1} p_1 v_1 \left[\left(\frac{p_2}{p_1} \right)^{\frac{n-1}{n}} - 1 \right]$$

$$= \frac{1}{n-1} p_2 v_2 \left[1 - \left(\frac{p_1}{p_2} \right)^{\frac{n-1}{n}} \right] \tag{23}$$

Instead of adding heat while the compression process described is progressing, a greater amount of mechanical energy might be supplied and a fraction equivalent to the heat added might be dissipated to produce heat by turbulence within the gas. Obviously, the compression curve would be unchanged but the area under the curve would no longer represent the work supplied. Such circumstances are representative of many actual irreversible compression processes.

It may be concluded, therefore, that for irreversible compression or expansion of an ideal gas

$$Q + W = u_2 - u_1 = C_v (T_2 - T_1)$$

There is one important special case of polytropic compression which has not yet been noted. It has the following characteristics.

Isothermal (Constant Temperature)—

$$n = 1, pv = \text{constant} = RT$$

$$\frac{dQ}{dW} = \frac{1-k}{k-1} = -1, dQ = -dW$$

This indicates that heat must be removed at the same rate compression work is done.

$$-Q = W = p_1 v_1 \log_e \frac{p_2}{p_1} = RT \log_e \frac{v_1}{v_2} \qquad (24)$$

For any polytropic compression or expansion

$$\frac{p_2}{p_1} = \left(\frac{v_1}{v_2}\right)^n = \left(\frac{T_2}{T_1}\right)^{\frac{n}{n-1}}$$

Example (2)

An ideal gas of molecular weight 28 has a constant pressure specific heat of 0.24. It is compressed in a cylinder along a polytropic curve $pv^n = \text{const.}$ from $T_1 = 500$ R to $T_2 = 650$ R. (a) What is the total amount of work and heat supplied per pound of gas? (b) If the pressure ratio, $\left(\frac{p_2}{p_1}\right)$, of the compression is 2.3 and the heat removed is 3,250 ft lb per lb of gas, what part of the work of compression is irreversible? (c) If the gas is expanded reversibly and adiabatically back to the original pressure, how much work is done per pound?

(a) $W + Q = u_2 - u_1 = C_v (T_2 - T_1)$

$$C_p - C_v = \frac{R}{J}, \quad R = \frac{1545.3}{28} = 55.2$$

$C_p - C_v = 0.24 - C_v = 55.2/778 = 0.0710$
$C_v = 0.24 - 0.071 = 0.169$, $k = .240/0.169 = 1.42$
$W + Q = 0.169\ (650 - 500) = 25.35$ Btu per lb
$W + Q = 25.35 \times 778 = 19{,}750$ ft lb per lb

(b) If 3,250 ft lb per lb of heat is removed, the actual work done from (a) is

$W + Q = 19.750 \qquad Q = -3{,}250$
$W = 19{,}750 + 3{,}250 = 23{,}000$ ft lb per lb

To solve for n

$$\frac{p_2}{p_1} = \left(\frac{T_2}{T_1}\right)^{\frac{n}{n-1}} = 2.3 = \left(\frac{650}{500}\right)^{\frac{n}{n-1}}$$

$$\frac{n}{n-1} = 3.17 \qquad n = 1.465$$

If the compression were a reversible polytropic

$$\frac{Q'}{W'} = \frac{n-k}{k-1} \text{ and } \frac{Q'+W'}{W'} = \frac{n-1}{k-1} = \frac{.465}{.42} = 1.11$$

For the same end temperatures

$$Q' + W' = Q + W = 19{,}750 \text{ ft lb per lb}$$

The reversible work

$$W' = \frac{19{,}750}{1.11} = 17{,}800 \text{ ft lb per lb}$$

Irreversible work $= 23{,}000 - 17{,}800 = 5{,}200$ ft lb per lb

(c) For reversible expansion

$$\left(\frac{T_3}{T_2}\right)^{\frac{k}{k-1}} = \frac{p_3}{p_2} = \frac{1}{2.3}$$

$$\frac{T_3 - T_2}{T_2} = \left(\frac{1}{2.3}\right)^{\frac{k-1}{k}} - 1 = -0.218$$

$T_3 - T_2 = -0.218 \times 650 = -142$F
$W = C_v (T_3 - T_2) \times 778 = -0.169 \times 142 \times 778$
$= -18{,}700$ ft lb per lb

Example (3)

Air expands through a nozzle starting at a zero velocity and an initial temperature of 700°R. The final pressure is $0.8 \times p_1$. (a) If the exit velocity is 650 ft per sec, what is the temperature of the issuing jet? (b) How much of the available mechanical energy has been dissipated in the stream? ($k = 1.40$, $C_v = 0.171$ and $C_p = 0.240$)

(a) From the steady flow equation

$$\frac{V_2^2}{2g} = J (h_1 - h_2) = JC_p (T_1 - T_2) = \frac{(650)^2}{64.4} =$$

6,570 ft lb per lb

$$C_p (T_1 - T_2) = \frac{6570}{778} = 8.44 \text{ Btu per lb}$$

$T_1 - T_2 = 8.44/0.240 = 35.2$F.
$T_2 = 700 - 35.2 = 664.8$°R.

(b) For reversible expansion to p_2 and T_3,

$$\frac{1}{0.8} = \left(\frac{T_1}{T_3}\right)^{\frac{k}{k-1}} \text{ from which } \frac{T_1}{T_3} = 1.0659$$

$$T_3 - T_1 = -\frac{T_3}{T_1}\left(\frac{T_1}{T_3} - 1\right) \times T_1 = -43.3\text{F}$$

$$\text{Mechanical energy} = \frac{V_3^2}{2g} + p_3 v_3 - p_1 v_1 = u_1 - u_3$$

For the actual expansion—

$$\text{Mechanical energy} = \frac{V_2^2}{2g} + p_2 v_2 - p_1 v_1 = u_1 - u_2$$

The mechanical energy dissipated is therefore

$(u_1 - u_3) - (u_1 - u_2) = C_v (T_2 - T_3)$
$= 0.171\ (43.3 - 35.2) = 1.37$ Btu per lb.

Note that although the kinetic energy of the irreversible expansion is less, the net flow work released is greater.

Part 2 of Mr. Palmatier's reference work on thermodynamics will deal with applications and psychrometry, and will appear in a subsequent issue.

Burning Bituminous Coals on an Anthracite Domestic Stoker

In times of anthracite shortage it may be convenient to burn bituminous coal in household stokers. This article is based on investigations reported* by H. F. Yancey and K. A. Johnson for the Bureau of Mines and deals with practicable substitute fuels which can be burned successfully in anthracite stokers.

A STUDY of the use of bituminous and subbituminous coals with higher ash-softening temperatures for use with the domestic type of stoker was made at the Northwest Experiment Station, Bureau of Mines, Seattle, Wash. The work was undertaken to enable mines producing this kind of coal to enter the stoker coal market and also that home owners in the east might learn how to burn successfully the bituminous caking coals in case of a shortage of anthracite.

The ash-removal type underfeed stoker that was used in this study was designed to burn Pennsylvania anthracite. The domestic type boiler used had a rated capacity of 565 sq ft of steam radiation or 905 sq ft of water radiation. Eight representative Washington state coals were tested.

With few exceptions, dry stoker coals feed without difficulty although coals with an excessive amount of fines and containing certain kinds of impurities did pack in the hopper, even in the dry state. Where the coal was sized and the fines removed, the feed was satisfactory regardless of whether dry or dustproofed with water, oil, or other agents.

Tests showed that non-caking coals burn more efficiently on an anthracite, ash-removal type underfeed stoker than do the group of caking coals. At low feed rates, the over-all efficiencies for the non-caking coals tested averaged 77.7% as compared with 67.8% for the caking coals. At medium feed rates the efficiencies for the non-caking coals dropped to 74% because of higher dry gas losses, and the reduction for the other group to 64.2% was due to greater losses in the ashes.

The heat-balance trials showed that even the heaviest caking coal tested burned fairly efficiently (66.0%) at low feed rate, and showed 63.0% at medium feed rate. If necessary, it could be used in the stoker. The lightest caking coal showed an efficiency of 72.8% at low feed rate and 65% at medium feed rate. However, because of the grinding of the coke in the ash-remover with its resulting objectionable noise, and the large amounts of unburned coke in the ashes, the caking coals were not found suitable for this type stoker.

Other tests showed that non-caking bituminous coals burn much more readily than any other solid fuels and therefore should be suitable for all types of stokers provided the ash-softening temperature is found suitable for each stoker used.

Anthracite will not burn satisfactorily with the required output on either the overfeed or the clinkering type bituminous underfeed stoker because of its low combustion rate.

The five non-caking coals tested burned efficiently on an anthracite ash removal type underfeed stoker with a low value for the losses due to unburned combustible material in the ashes. Dry gas loss was influenced mostly by the rate of heat release and by the extent of the flame travel.

While ash-softening temperatures did affect the character of the fuel beds and the mechanical removing of the ashes, it did not affect the efficiency of the burning operation nor the amount of unburned combustible in the ashes. All the coals formed clinkers ranging in strength and density from a very soft porous clinker to a hard completely fused clinker.

Fuel beds of the caking coals were thick and uneven. Large pieces of soft coke fell or were pushed from the retort with resulting high ash losses. Blow holes in the fuel bed, however, did not substantially affect the dry flue-gas loss.

All except one coal burned with very little smoke, especially at low feed rates. The amount of soot deposited with all coals was small.

H. F. Yancey and K. A. Johnson in reporting the investigation gave the following summary of the findings:

Non-caking bituminous and subbituminous coals with ash-softening temperatures above 2,600F burned with high efficiency, showing the efficiency of using anthracite stokers to burn this type of coal for actual house heating. Coals with ash-softening temperatures as low as 2,380F also were burned with high efficiency but the noise made by the ash removal mechanism in crushing clinkers might be undesirable in a home. Stokers of this type are especially desirable for burning high ash coals because the labor and inconvenience of handling the ashes is minimized.

Caking coals are generally suitable for this type of stoker but coals caking only slightly may be used at some sacrifice in efficiency occasioned by the loss of unburned coke in the refuse. During times when emergency substitution of coal becomes necessary, weakly caking coals could be burned in anthracite ash removal type stokers with a reduction in efficiency of only 10 to 15%.

*Bureau of Mines Report of Investigations 3849.

Graphical Determination of Heat Transfer Film Coefficient for Liquid Freon-114*

B. F. RABER ** and F. W. HUTCHINSON ***

THE physical properties of Freon-114 are such that the film coefficient of heat transfer increases with temperature in the range from 0F to approximately 25F, then remains practically independent of temperature in the range from 25F to 75F, then decreases with increasing temperature in the range from 75F to 100F. This characteristic occurs with liquid Freon-114 whether being heated or cooled and whether flowing inside a pipe or outside and normal to a single pipe. In the latter case, however, the variation of film coefficient with temperature is so small as to be of no practical significance and for the purposes of this article it has been considered that the value of h (film coefficient) for liquid outside a pipe can be taken as independent of temperature. A visualization of the physical reason for the seemingly inconsistent temperature variation of the film coefficient can be obtained by plotting the specific heat, density, and thermal conductivity as functions of temperature, then plotting the film coefficient on the same figure; this was done in the last installment of this series[1] (for Freon-113 in the June, 1946, issue of H. & V.).

Fig. 19 is for liquid inside a pipe and is identical in form to the 18 previously published graphs of this series. The solid horizontal lines in the upper section of the chart are for liquid heating whereas the dashed horizontal lines in the same chart section are for liquid being cooled; the scales for fluid heating or cooling are on the right and left sides, respectively, of the graph. As previously discussed, one horizontal applies in the temperature range from 25F to 75F. Fig. 20 is for liquid outside and normal to a single pipe and differs from Fig. 19 in that the base scale of film coefficients is directly applicable to fluid either heating or cooling and for any temperature in the range from 0F to 100F.

Example: Heat transfer is occurring through a very thin walled copper tube that is 1½ in. in diameter. Conditions are such that the mean temperature difference is 70F, the mean temperature of the liquid being cooled outside the tube is 100F and the mean temperature of the liquid heating within the tube is 0F. The velocity across the outside of the tube is 3 fps while that within the tube is 5.75 fps. Neglecting the thermal resistance and the thickness of the tube wall, determine what length of tube is needed to establish a heat transfer of 50,000 Btu per hr.

Solution: Enter Fig. 19 at the velocity scale at the bottom of the graph and rise vertically (as shown by the dashed example line) to intersection with the horizontal for 1½ in. pipe diameter. From this intersection follow a directrix line up to the base scale for film coefficient and from this intersection rise vertically to meet the horizontal solid line for fluid heating at a temperature of 100F. From this point follow a directrix line back down to intersection with the base scale at a film coefficient value of 320 Btu per hr per sq ft per degree temperature difference.

Enter Fig. 20 at a velocity of 3 fps and rise (as shown by dashed example line) to intersect the 1½-in. diameter horizontal; then follow a directrix up to intersection with the base scale at a film coefficient of 170 Btu per hr per sq ft per degree mean temperature difference.

Since the thermal resistance of the tube wall is to be neglected the total fluid-to-fluid resistance is the sum of the resistances of the inside and outside films,

$$R = r_i + r_o = (1/320) + (1/170)$$
$$= .0031 + .0059 = .0090$$

and the overall coefficient of heat transfer is therefore,

$$U = 1/R = 1/.0090 = 111 \text{ Btu per hr per sq ft per degree.}$$

Then applying the usual equation for heat transfer,

$$q = UA\ (\triangle t) = 50{,}000 = 111\ (A)\ (70) \text{ giving,}$$

$$A = 6.4 \text{ square feet of heat transfer surface.}$$

The area of one lineal foot of 1½-in. diameter tube is,

$$A = (\pi)\ (1.5/12) = 0.393 \text{ sq ft}$$

Therefore the length of tube needed to permit a 50,000 Btu/hour heat transfer rate will be,

$$L = 6.4/0.393 = 16\tfrac{1}{4} \text{ ft.}$$

Consider, now, that this length of single tube is broken up into eight sections of equal length arranged in a staggered tube bundle and so spaced that the *maximum* velocity of fluid outside and normal to the bundle is the same as the velocity outside the single tube (3 fps). In this event the value of the outside film coefficient will be 30% greater than the previous case (see article for brine in March, 1945, H. & V.) and the overall coefficient will therefore be,

$$U = \frac{1}{\dfrac{1}{1.3 \times 170} + \dfrac{1}{320}} = 1/(.0045 + .0031)$$
$$= 1/(.0076) = 131.5$$

and the total heat transfer rate (for the same mean temperature difference) will be,

$$q = 131.5 \times 6.4 \times 70 = 59{,}000 \text{ Btu per hr.}$$

*Freon is a copyrighted trade name held by Kinetic Chemicals Co.

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***Professor of Mechanical Engineering, Purdue University, Lafayette, Indiana.

[1]Previous articles of this series have appeared in HEATING AND VENTILATING for Dec. '44; Jan., Feb., Mar., Apr., June '45; Apr., May, June 1946.

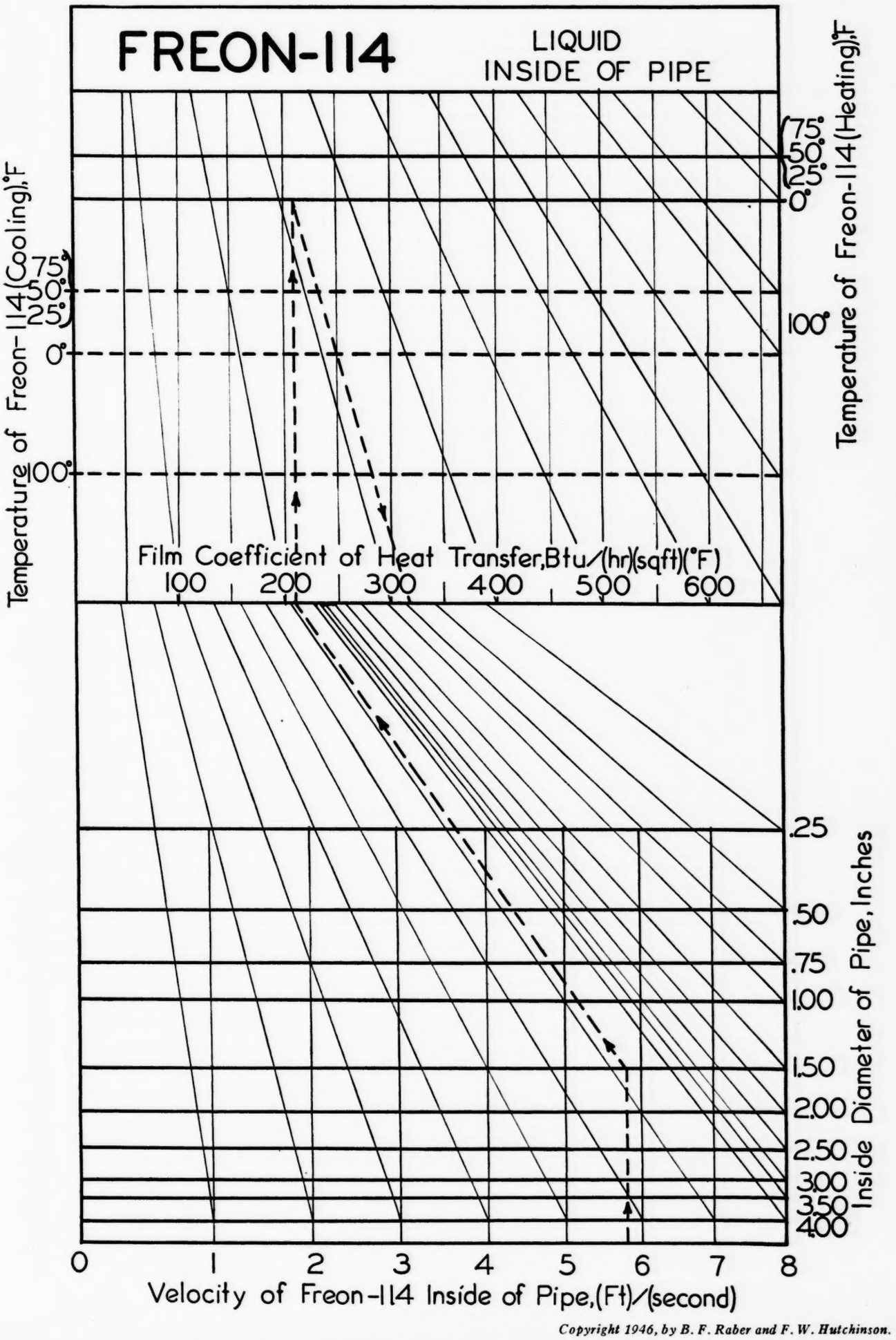

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Fig. 19. Film coefficient for liquid Freon-114 flowing inside a pipe.

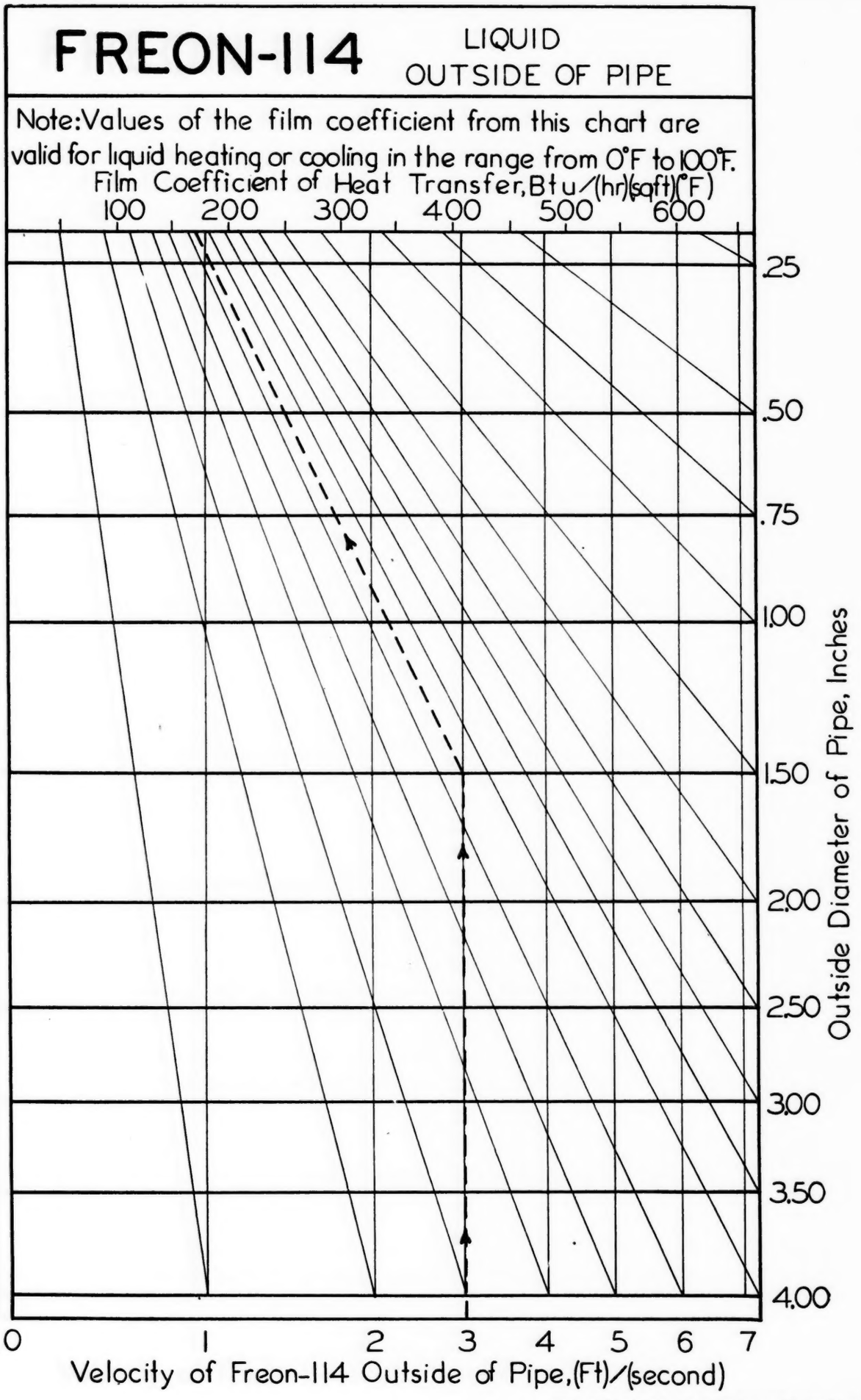

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Fig. 20. Film coefficient for liquid Freon-114 flowing outside a pipe.

Piping Details Are Important in Steam Heating Returns

T. W. REYNOLDS

The author discusses two common problems—that of equalizing return lines from various sources, and that of getting a return past a doorway. In the latter he shows that an old, old piping detail has some serious faults, and recommends a more practicable solution.

CERTAIN heating problems, while routine to a sales engineer who specializes on equipment such as pumps and traps, or what not, are not so simple to the design engineer who meets the problem infrequently. Some of the details of steam return lines are in this category, and this article deals with two such problems.

Equalizing Returns

One problem is that of returning condensate from sources which vary in elevation, lift required, concentration, or fluctuations due to modulating control. This is the type of problem which the designer sometimes picks up abruptly and hurries through with, leaving the trouble magnified rather than corrected, simply because the real trouble is not the trouble as he sees it. One cannot find the solution to a problem if he is not first very clear in his own mind as to the nature of the problem itself.

Fig. 1 shows an actual installation, not a hypothetical one. It concerns a steam heating system maintained at 7 lb pressure with an overhead vacuum return from radiators above it and unit heaters with outlets about 3 ft below it. Near the pump are the heating coils of the air conditioning system with traps on the lowest outlet about a foot below the pump inlet, though the nearness of the coils to the pump is not the real problem. True, the long overhead return loses some temperature by the time it reaches the pump, but so do the returns from the coil when delayed due to modulating control.

When the temperature control valve is wide open to admit full steam pressure to the coils there would be no difficulty in lifting their condensate to the main overhead return, even though the lift is about three times as great as the individual lifts from the unit heaters. The difference in pressure between that within the steam main (held steady at 7 lb by a make-up pressure reducing valve) and the below atmosphere pressure in the return main (which will vary at times) is never so low with the control valve held open but that the differential pressure would elevate the condensate to the overhead return and even a bit beyond.

Now when the control valve throttles or modulates downward it may soon reach a point where natural condensation within the coil may produce a vacuum greater than that in the main return, especially at the time the pump is started for heating of the system in the morning. Then, as the valve closes, there is no differential left to elevate the returns except in a reverse direction, so that the return from the coils are flooded.

Various remedies have been tried or suggested for such conditions. In a recent installation, it was proposed to deliver the coil condensation separately by gravity to a hot well in the adjacent boiler house. This presented certain advantages. The cost of pumping and the first cost of the pump were thereby reduced somewhat, though largely offset by the cost of a long return run inside of a larger pipe. The return pipe, being buried, would also lose heat, be inaccessible, and liable to corrosion. Another point is that the end of the line to the vented hot well would be open to atmosphere, so that the atmospheric pressure would hold up the return of condensate when the coil was under its own natural vacuum. This, however, would be only momentarily, as the difference in pressure between the vacuum at the coils and in the hot well would be considerable; hence atmospheric pressure would be quickly sucked back to break the vacuum.

This apparent advantage of breaking the vacuum is the real disadvantage of a return by way of hot well. Atmospheric pressure would, of course, deliver air back at the coils where it would interfere with the

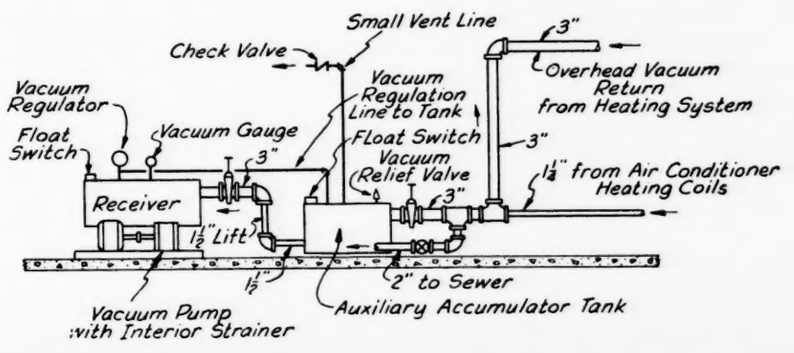


Fig. 1. Sketch of auxiliary accumulator tank and connections to equalize returns at vacuum return pump.

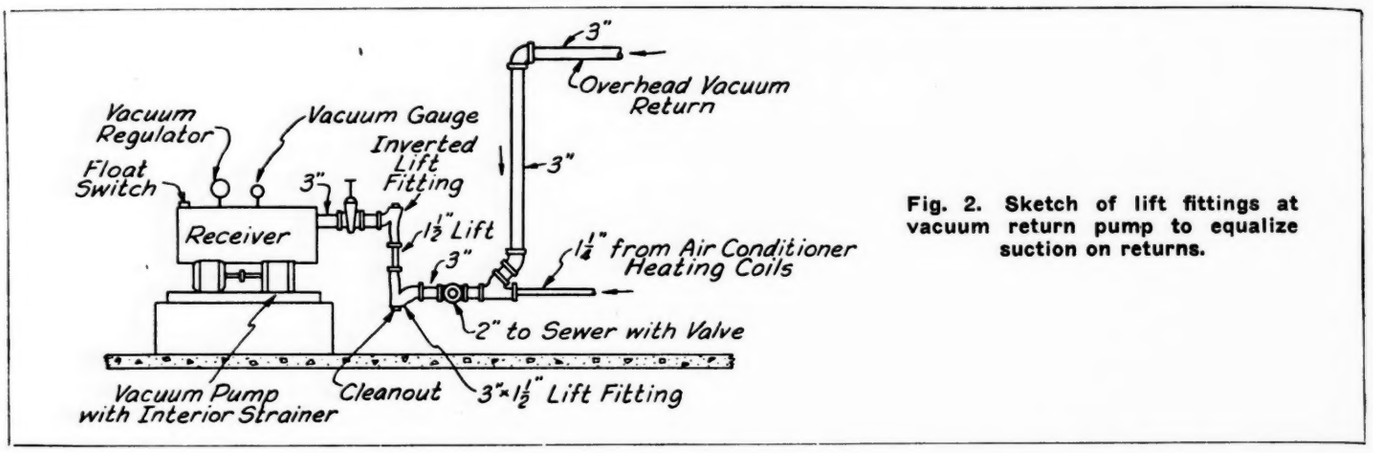


Fig. 2. Sketch of lift fittings at vacuum return pump to equalize suction on returns.

modulating effect of the controls, practical experience having demonstrated that the results obtained by controls are more stable when variations imposed on the controls are of no magnitude. It is true that an adjacent hot water heater was so arranged as to deliver its returns to the hot well, but it was nearby, at a high elevation, and the control of temperature was not so important as in the case of the air conditioning heating coils; furthermore, being separated from the vacuum heating system, it could be equipped with a vacuum breaker set for the degree of vacuum desired.

It was next proposed that the heating coils be elevated sufficiently for gravity return to the pump inlet, as the necessary elevation was obtainable, though objectionable physically. However, such a method would not have produced a return of water from a coil under its own vacuum when the pump was clearing the long overhead returns on start up. This, then, resulted in raising the question of an accumulator tank, as in Fig. 1, in which, when the condensate had accumulated, a float would rise to switch on the pump. The arrangement would not be exactly as shown, for it was proposed to deliver the overhead returns separately to the pump and lift only the heating coil returns by way of the accumulator tank. Why drop condensate from overhead only to pump it part way up again? The answer to this is that both returns must at all times be on an equal basis and that the one which must be lifted requires a greater vacuum than does the gravity return.

From this point, the evolution of design proceeded to the idea of lift fittings at the pump as shown in Fig. 2. Here everything was on an equal basis, at least as to lift required, but again there were certain objections. When the modulating control opened wide the coil condensate would suddenly appear to flood the lift, and at other times the overhead returns would be handled exclusively. Another disadvantage would be that the pump could not be run on night operation with only float switch regulation, for without the vacuum, air could not be vented from the return nor could the returns be lifted. If for any reason the pump became inoperative, the same difficulties would be experienced. Water hammer would also take place whenever the pump is first started up and continue until such time as the pump had created a sufficient differential to effect the lift.

Because of these factors, the exact arrangement as shown in Fig. 1 was finally adopted. In operational sequence, the pump is regulated to run so as to maintain a vacuum through the small connecting line from the top of the pump receiver to the top of the auxiliary tank. Condensate accumulates to seal the bottom outlet of the tank, making it in effect a lift fitting, for a difference in pressure quickly develops on each side of the seal; meanwhile the float switch on the tank rises to start the pump if it is not already in operation. As the accumulated water is cleared, the vacuum extends back to the system. The collection of condensate and the suction effect of the pump is then equal at all points and any sudden return of water from any one point can be momentarily stored in the tank without water hammer. All water is collected and treated alike—put on an equal basis and lifted as one

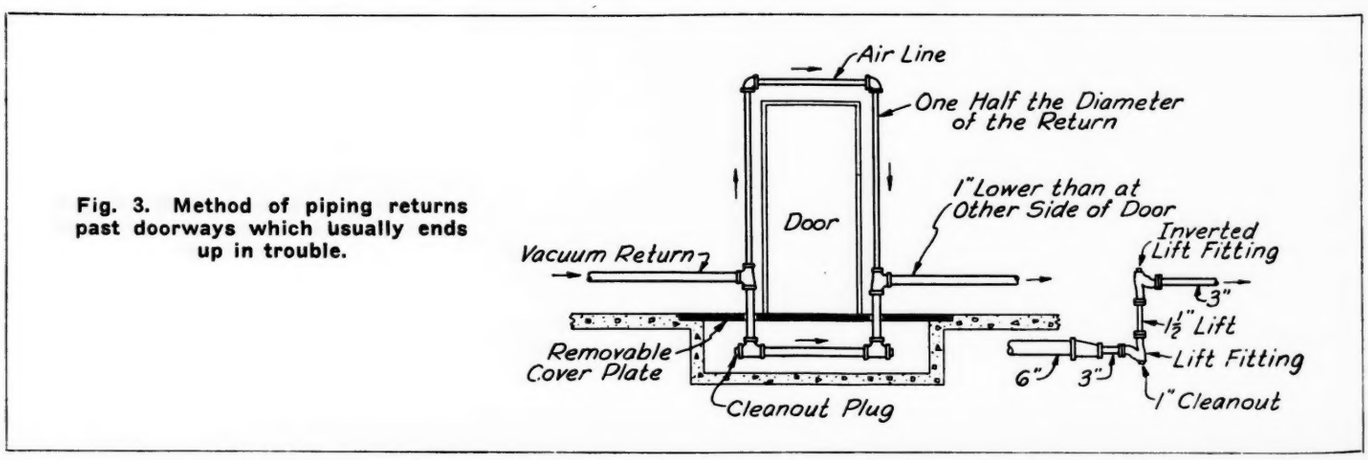


Fig. 3. Method of piping returns past doorways which usually ends up in trouble.

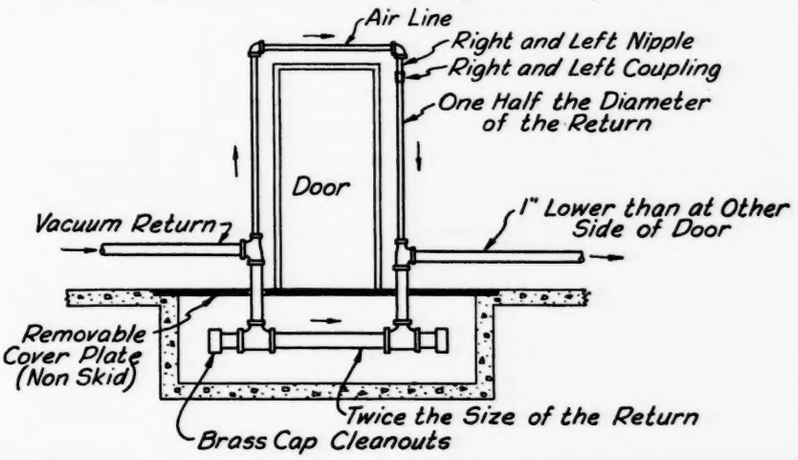

Air Line
Right and Left Nipple
Right and Left Coupling
One Half the Diameter of the Return
Door
Vacuum Return
1" Lower than at Other Side of Door
Removable Cover Plate (Non Skid)
Twice the Size of the Return
Brass Cap Cleanouts

Fig. 4. Piping returns past doorways in a way which will insure continuous flow.

body. Obviously, the heating coils must be at an elevation sufficient for their traps to drain by gravity to the tank inlet. This often requires a pit for the tank.

For night operation without vacuum regulation, a selector switch is operated so as to throw over to float switch operation; hence the need for the small vent line from the top of the auxiliary tank. It is extended up to a safe elevation with open end to atmosphere and fitted with a check valve to prevent return of air into the system. The check valve should be of a type requiring minimum resistance, so that it will readily vent on a very slight pressure.

The lift from the tank to the pump is treated the same as any lift containing lift fittings, the pipe size of lift pipe being made one-half the diameter of the return. This insures the maintenance of unbroken slugs of water going up the pipe as long as possible, less air gets through to break up the slugs and cause them to drop back; at any event, it has been found in actual practice that they work better that way. The usual inverted lift or hump at the top of the rise for the prevention of water dropping back from the return is not needed when a tank is used, as the discharge of water is greater under this arrangement and this is delivered close to the receiver. The tank outlet must be below the pump inlet. Incidentally, where suction lift fittings are used in lieu of a tank (as would be correct where returns are all below and from the same source), there must be sufficient space below the bottom lift fitting for removing its cleanout plug.

Returns at Doorways

Framing a door with a pipe loop in a vacuum return heating system in order to pass the air over and the condensate under is an old pipe fitting detail usually pictured as in Fig. 3. Note the innocent looking cleanout plugs and the convenient removable cover plate which leave the draftsman happy as he finishes the detail and the steam fitter equally as happy as he draws the plugs tight and departs complacently from a job well done. This sketch, however, shows a solution which settles nothing but the sediment and leaves, in effect, one long plug where two formerly existed.

An old heating contractor once told the writer that it is not a difficult matter to snake out the dirt pocket formed by the bottom of the loop, once the plugs are out, nor is it a problem to work on the plugs where sufficient room is left above and on sides of the plugs for the application of a wrench. This, he said, was seldom allowed for, and even where the plugs are accessible, he had in all of his years of experience never found one of these pockets that could be cleaned. You start off by putting kerosene on the threads, wait a little, apply the wrench, find immovable object, lay down the wrench, pound the plug to loosen it and then apply the wrench, but find cohesion as great as ever. Next you try the blow torch, for expansion provides a terrific stress, but nothing happens, so that you finally end up by cutting the entire contraption out.

Casting about for other ways out of such difficulties, one is lead to a design as in Fig. 4. The dirt pocket, for such it really is, should be fitted with caps rather than plugs, and the caps should be brass. Finally, and what is most important, the pocket should be made of liberal size, so that its complete stoppage will be delayed by many more years, or what is much more likely, may never occur.

The importance of the last mentioned point is rarely fully appreciated, for the filling of any pocket in a heating system is not caused so much by the sediment of today and an equal amount tomorrow, but rather most of it today and very little tomorrow. When a system is first installed it is supposed to be blown and run to the sewer for a time with trap parts, strainers and specialties removed and with temporary elbows and temporary trap covers used at radiators, though these are things seldom done even when specified to be done. When all this isn't done, the dirt in a new system collects rapidly in the pockets, traps, strainers, valves, controls and other specialties, so that a new job may become 90% clogged up in the first month at some very critical points. Complete stoppage, however, comes only after many years and would never have occurred had the initial cleaning been made. Where this first cleaning is not made there should be a sufficient space for the storage of initial sediment and the passage of the usual condensate flow over this sediment. Sad to say, in small installations most returns are not even provided with trenches, but are merely buried where, in time, they corrode and leak unnoticed.

Should the formula for the pocket "twice the size of the return" give too large a cap in brass, consideration may be given to reduction in cap size by the use at

each end of the pocket of a reducer, one of which should be eccentric (try to get one today!). The cover plate should be non-skid, and if it is so long as to be cumbersome or too heavy, can be built in sections. The return should be lower on the down stream side of the door to prevent flooding of the return on the opposite side. A slight static head is required to insure gravity flow against the resistance of the pipe, no matter how feeble the resistance may be. Directions of this nature are also necessary if for no other reason than their psychological effect; that is, to make certain that when the downstream side is installed it is no higher than on the upstream side.

The air or vent loop over the door does not enhance the appearance of the door, so that some try to avoid it by the use of lift fittings, as shown in the detail at the right in Fig. 3. Such fittings are not flanged in sizes smaller than noted and the plug at the bottom of the lower lift fitting is inaccessible. As dirt accumulates in the well at the base of the fitting the effectiveness of the lift becomes less and less, for the water is gradually crowded out. This is unfortunate, because one of the purposes of this well is to insure a collection of condensate sufficient to form a seal, thereby setting up a different pressure each side of the seal. This causes the water to be easily lifted because of its small quantity, yet gives sufficient water to fill the pipe area until the lift has been completed. To make this doubly certain, the lift pipe is made of small diameter, thus keeping air and vapor from bubbling through the slugs as they would in a pipe of larger bore. This prevents the slugs from falling back. Incidentally, these slugs when once over the interior hump at the top of the inverted lift fitting, cannot return, as would otherwise be quite likely with a flooded return downstream.

One advantage of the lift fittings is that the water seal is below the pipe, so that it is not necessary for the pipe to fill before condensate is discharged. The discharge is more or less continuous; lift fittings will, therefore, keep the depressed pipe somewhat cleaner than in the arrangement shown in Fig. 4. On the other hand, it is equally obvious that during the first few weeks of operation the dirt in the system is quite apt to foul the small well of a lift fitting and thus render it ineffective. A further disadvantage of the lift fittings is that they will not work on gravity flow as with night operation, at which time the pump is switched from vacuum regulation to regulation only by its float switch.

The writer has often wondered how any pipe fitter could get the air loop assembly together as shown in Fig. 3, and if he did, how he could get it apart. Fig. 4 gives the answer by way of a right and left nipple and a right and left coupling at some point in the air line over the door. In place of these two items, a union could be used, and the detail is sometimes so pictured by the draftsman. The union, however, never goes in, for it is too bulky; it does not permit enough space between it and the wall for application of a wrench.

The size of the pipe in the air loop is one-half the diameter of the return. For example, an installation of 20,000 sq ft of radiation would have a 3-in. return and therefore a 1½-in. loop, though many such installations have worked satisfactorily with a loop of only ¾-in. pipe. If smaller, the velocity might be so great when first clearing the system of large quantities of air that water would be picked up by the loop with resulting water hammer.

Larger sizes are not objectionable aside from appearance, but smaller sizes are. The high velocity through a very small pipe size will cause a pressure drop through the loop great enough to set up a substantial pressure differential between the inlet and outlet of the loop. This will cause a fluctuation in the water in the return pocket as it partially lifts up in the rise to the downstream side. If this bore is too large, some of the slugs of water will fall back, while vapor may be trapped by the fluctuations along the top inside of the horizontal pocket, and pounding results.

Hazards of Welding Fumes

Nitrogen dioxide is recognized as a potential health hazard in welding operations, according to Hervey B. Elkins of the Division of Occupational Hygiene, Massachusetts Department of Labor and Industries, in the *Journal of Industrial Hygiene and Toxicology.*

Actually nitric oxide is produced in the electric arc but this oxidizes rapidly to nitrogen dioxide. Under favorable conditions air which has passed through an electric arc contains from 1-2.5% of NO. Since Nitrogen dioxide is unstable at high temperatures, it does not form until the gas has been materially cooled.

While nitric oxide has certain toxic effects, it is not an irritant gas. For example, in welding fumes the gas mixture becomes more irritating with time and in proportion to the square of the concentration. The irritant gas hazard from such a system will respond much more rapidly to changes in ventilation than will the usual fume hazard.

Studies were made of the composition of fumes from various coated welding rods. The average NO_2 concentration was found to be 0.33 parts per million. Other investigators, in a similar study, found the average concentrations to be 25 ppm.

The maximum allowable concentration of oxides of nitrogen for continued exposure, recommended by the American Standards Association, is 25 ppm. However, the recommendation of the Massachusetts Division of Occupational Hygiene is 10 ppm. If the statement that 55 ppm for 2-3 hours exposure is dangerous is accepted, then the maximum allowable concentration for 8-hour exposures, allowing for variations in susceptibility and a modest margin of safety, could hardly be above 10 ppm. When compared with the values commonly accepted for other irritant gases of comparable toxicity, such as chlorine, the greatest permissible concentration for NO_2 should be 5 ppm or less.

Weather-Compensated Control for Radiant Heating

J. A. CUTLER
President, Johnson Service Company, Milwaukee, Wis.

The subject of control of radiant heating systems is one of especial interest at the present time. The accompanying article, based on a recent talk by Mr. Cutler before a group of engineers in Milwaukee, outlines his company's thinking on this matter, and involves application of that company's weather-compensated Duo-Stat control for radiant panel heating.

BECAUSE of the inherent thermal inertia in radiant heating panels the need for a change in the temperature of the radiant surface must be measured before it is reflected by a change in space conditions, if these space conditions are to be held substantially constant. In most cases, the internal heat load is relatively constant, and the need of a change in surface temperature arises immediately upon a change in outdoor temperature. Therefore, for the primary control of a radiant heating system, an arrangement which varies the surface temperature according to changes in outdoor temperature is necessary. The above reasoning leads to the conclusion that a weather compensated control offers the best possibility of effecting superior results with a radiant heating installation.

An analysis of the functioning of a radiant heating system under weather compensated control may serve to indicate further the advantages of this method. Assume that a drop in outdoor temperature occurs. The control immediately increases the heat input to the coils. However, due to the thermal inertia of the system, a certain amount of time elapses before this manifests itself by an increase in the temperature of the radiant surface. On the other hand, the drop in outdoor temperature does not immediately effect a change in the heating load on the system because of the time required to transmit this change through the building structure. Therefore, with the weather compensated control, the thermal inertia of the radiant surface not only ceases to be a hindrance to good results, but definitely improves results because it is not desirable to change the heat output of the surface until the change in outdoor temperature becomes effective indoors.

Primary Controls

In the following paragraphs are outlined recommended methods of primary control for radiant heating, keeping in mind that installations vary considerably in many details. The descriptions, therefore, are general rather than specific.

(1) An example of a simple application of a weather compensated control to radiant heating is the operation of a valve in the steam supply to a hot water converter. This, of course, can apply only where the converter serves one zone.

(2) When a radiant surface is heated from a cold condition, i.e., when the system is first operated, or after a prolonged shutdown, the coils and the material immediately surrounding the coils become warm much sooner than the rest of the radiant surface. This causes a differential expansion which, in time, may injure the material which comprises the surface. Some engineers, therefore, have insisted on gradually increasing the maximum water temperature over a period of several days. To accomplish this, an immersion thermostat should be installed in series with the weather compensated control, with its bulb in the converter discharge. If both are reverse acting, operating a normally closed valve, the immersion thermostat acts as a high limit control and can be adjusted as desired. If it is undesirable to use a normally closed valve, the same results may be accomplished with direct acting controllers, allowing the immersion thermostat to function through a 3-way air valve.

Either method (1) or (2) may be used also in connection with the control of an automatic hot water boiler, instead of a converter. The weather compensated control would be used directly to govern a stoker, oil burner, or gas burner.

(3) A slightly more elaborate arrangement is to control a valve in the steam supply to a converter by an immersion thermostat only, set for a temperature equal to the highest requirement. The weather compensated control, then, operates a 3-way valve to control the water temperature to the zone. This arrangement is applicable where the converter serves any number of zones. The immersion thermostat still can serve as a means of gradually bringing the radiant surface up to temperature, as outlined in method (2). The advantage of method (3) is that the use of mixing valves as the final control insures less variation in the zone water temperature than occurs when the control is arranged as described for method (1).

(4) Method (3) makes use of an immersion thermostat to control the hot water temperature supplied to the zone mixing valves. This temperature is the highest which will be needed under severe weather conditions. Under mild weather conditions the weather compensated controls are required to mix a small amount of very hot water with a larger quantity of cool return to produce the required zone water temperature. A more uniform water temperature would result if the hot water from the converter could be

always about fifteen or twenty degrees above the required zone water temperature. This suggests the use of another weather compensated control, in place of the immersion thermostat in the hot water line from the converter; this control would have its outdoor bulb on the coldest exposure and a ratio equal to the highest ratio used on any of the zones.

(5) In any of the primary control methods suggested, it might be desirable to arrange the controls so that the zone circulating pump is stopped whenever there is no longer a demand for heat. Thus, a pressure-electric switch would be installed so that the branch pressure from the zone weather compensated control would stop the pump after it has closed the valve to hot water.

Space Controls

To obtain closer control of the space temperature than is possible with primary control alone, room thermostats should be used, to limit or modify the action of the primary controls, as follows:

(a) As a limiting device, a room thermostat is installed in the zone, connected in series with the primary control, and if both the weather compensated control and the room thermostat are reverse acting, the room thermostat functions as a high limit, cutting off the supply of heat to the coils whenever the space temperature exceeds its setting;

(b) As a modifying device, a room thermostat, in the zone, is used as a pilot to readjust the primary control. Thus, with weather compensated primary control, the control is of the sub-master type, and the room thermostat serves to modify the setting of the weather compensated control in accordance with changes in room temperature; and

(c) Further refinement in space control can be accomplished by eliminating the zone thermostats mentioned in method (b) and installing thermostats in each room. These thermostats would operate throttling or 3-way valves in the supply lines to the panels in their respective rooms.

Forced Ventilation

To maintain room air temperatures that are much below the mean radiant temperature of the surrounding surfaces, some form of forced ventilation is required. Control of the forced ventilation system need be no different than when used with direct radiation; that is, a fan discharge thermostat regulates the temperature of the air delivered to the space at a level equal to, or slightly below, the desired space temperature. Use of forced ventilation should not alter the basic control system for the radiant heating plant.

The ventilation system is sometimes designed to carry part of the heating load, just as is done with direct radiation. This arrangement is more often used to supplement radiant heating surfaces located in floors. Control of the temperature of the air delivered would be by one of the following methods:

(1) A submaster fan discharge thermostat reset by an outdoor master thermostat. If supplementary heating is needed only during period of lowest outdoor temperatures, the master thermostat would be adjusted to operate only over this range. Assume design temperatures of —10F and a radiant system that can carry the heating load unaided at outdoor temperatures of 20F and higher. Then the master thermostat would be set to produce full resetting effect from 20F to —10F. At all other times the fan discharge thermostat would control at its base setting;

(2) The fan discharge controlled as in (1) with a room thermostat acting as the master to the fan discharge thermostat; and

(3) The fan discharge controlled by a room thermostat directly, in conjunction with a low limit, fan discharge thermostat.

In either of the last two methods, the fan system supplements the radiant heating system whenever the space temperature drops below the room thermostat setting.

Refrigerated Storage for Seed Corn

Cold storage and dry storage add up to safe storage of seed corn. Tests that prove this fact promise security and money economy in the safe-guarding of seed corn—particularly the tested and proved inbred strains of corn on which growers of hybrid corn depend for their parent seed stocks. The U. S. Department of Agriculture and the Ohio Experiment Station have recently announced satisfactorily high germination from seeds stored for five years in sealed tin cans and kept in cold storage. Seeds stored at room temperature were not reliable as seed after five years.

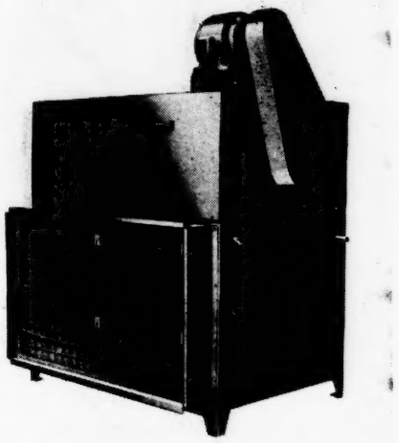
Corn growers ordinarily plant most of the crop from seed grown the previous year—about 6 months from harvest—and expect good germination. If drought injures the yield or if an early freeze strikes the corn before the seed is mature, many growers are likely to have to rely on "old seed"—18 months from harvest. In such cases well-dried and well-stored seed may sell at a premium, but the situation is rarely critical, and the expense of special storage might not be warranted for the general run of seed corn.

With the inbred lines the situation is different. These are valuable not only because of the work that has been done in inbreeding, but also because the crosses and double-crosses from such lines have been tested in the field. Seed corn growers know what to expect from a given cross. Loss of even one of the lines by drought or freezing would be serious, because much of the work of testing a substitute would have to be done over. If reserve supplies of foundation seed can be stored safely in dry cold storage, it will mean insurance.

NEWS OF EQUIPMENT AND MATERIALS

Climate Changer

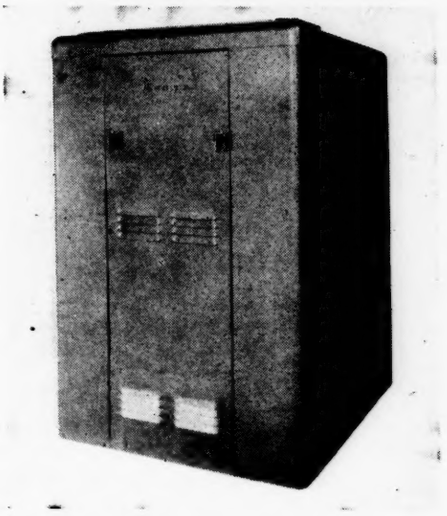
NAME—Trane climate changer.
PURPOSE—Control of air conditions.
FEATURES — Unit has been completely redesigned and parts may be included or excluded to provide any combination of air conditioning without interfering with basic design. Casings of the unit can be furnished insulated or uninsulated. Unit will have space for face and by-pass dampers without taking away any coil space. Each unit has eight rows of tubes in addition to face and by-pass dampers and filters. Vertical units have coils in the intake so that air and condensate travel in the same direction.



This arrangement places the humidifier, when it is used, on the leaving side of the coil and prevents freeze-up in the humidifier. Both throwaway and cleanable filters can be used in the V-type filter boxes.
SIZES AND CAPACITIES—Twelve sizes available in the horizontal model and eight in the vertical, with capacities ranging from 450 to 16,250 cfm.
MADE BY — *The Trane Company, La Crosse, Wis.* **64**

Oil Burning Furnace

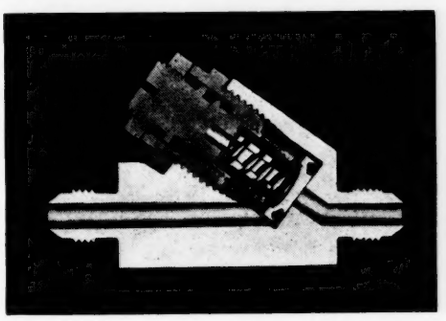
NAME — Norge vacuum-draft oil-burning furnace.
PURPOSE—Chimneyless furnace for general space heating.
FEATURES—Furnace is designed to create its own draft through a suction fan which pulls air through the combustion chamber. Chimneys



generally necessary for draft may be eliminated and an exhaust fan may be substituted for the chimney. Furnace filters and humidifies the heated air.
SIZES AND CAPACITIES—Furnace is available in three models, the largest of which develops 120,000 Btu bonnet output.
MADE BY — *Norge-Heat Division, Borg-Warner Corp., 574 E. Woodbridge St., Detroit 26, Mich.* **65**

Pressure Relief Valve

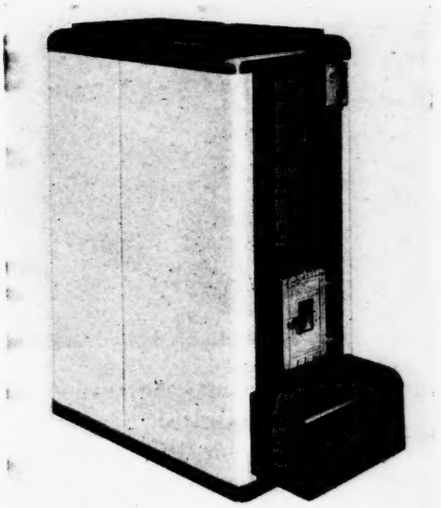
NAME — Aerotec pressure relief valve.
PURPOSE — For maintaining hydraulic lines at pre-determined pressures.



FEATURES—Valve can be set to the desired pressure without interrupting its operation by means of an outside adjustment screw. Inlet and outlet are on a straight line.
SIZES AND CAPACITIES—Available for pressures from 5 to 100 lb per sq in. Units have individual ranges of about 15 lb per sq in.
MADE BY — *Aerotec Co., White Plains, New York.* **66**

Warm Air Furnace

NAME—Hoffman warm air furnace, model HB-75.
PURPOSE—House heating.
FEATURES — Unit has a two-stage burner. On high fire, flame leaves the burner bowl and burns above the ring. Mechanical draft provisions make unit independent of natural draft conditions. Door to combustion chamber is cast-iron and is provided with a flame window. Two models are available; one for homes with basements and one for utility rooms where the house does not have a basement. Unit can be used with or without



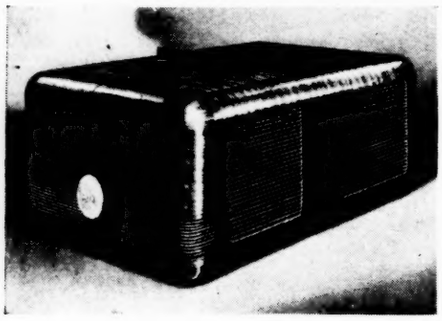
ducts to meet the heating demands of any space within its capacity.
MADE BY—*Hoffman Specialty Co., Indianapolis 7, Ind.* **67**

Metal Coating

NAME—Plasticlad.
PURPOSE—Corrosion resistant metal roofing and siding.
FEATURES—Roofing and siding material are covered with a copolymer resin coat which is sprayed and then baked to form a strong bond with the metal. Coating comes in various colors. This material is available as a roofing and siding and can be used for ventilators, flashings, and fastenings.
LITERATURE AVAILABLE — Catalog No. 945.
MADE BY—*Reliance Steel Products Co., McKeesport, Pa.*.....**68**

Air Conditioning Unit

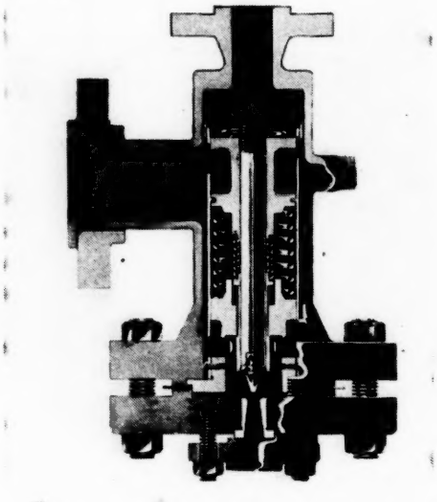
NAME — Pacific air conditioning unit.
PURPOSE—Room air conditioner.
FEATURES—Window-type, self-contained unit has a ½ hp motor driven, hermetically sealed twin-cylinder, refrigerant compressor. Room side section of the cabinet contains filter, cooling coil, outlet duct and motor-driven fan. Equipment is enclosed in a steel cabinet 22½ in. wide, 24½ in. long, and 13⅝ in. high. Cabinet has one-inch thick lining of fibre glass as insulation against heat and sun. Unit is controlled by a thermostatic expansion valve which has a pressure limiting feature. If desired,



air conditioner may be turned off and only fan operated.
MADE BY—*Pacific Manufacturing Corp., 5308 Blanche Ave., Cleveland, Ohio.* 69

Recirculating Valve

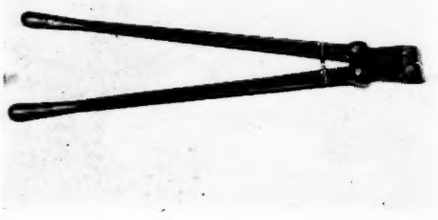
NAME—Hammel-Dahl recirculating valve.
PURPOSE—For eliminating centrifugal pump failures due to insufficient fluid flow.
FEATURES—Unit consists of an automatic recirculating valve operated from the fluid flow and designed to by-pass the minimum quantity of fluid required to eliminate pump overheating. As the amount of fluid through the pump increases, the by-pass quantity is automatically throttled and is reduced to zero when pump output is sufficient to prevent pump failure. Valve may be installed in existing pump piping by removing an elbow in the discharge piping upstream of all checks and stops.



OPERATION — When the discharge rate starts to increase, the plug in the valve approaches its seat and decreases the amount of flow recirculated. When the flow in the discharge line is sufficient, the by-pass valve closes tight and all output passes through the discharge line. Cycle is reversed when flow decreases.
MADE BY — *Hammel-Dahl Co., 243 Richmond Street, Providence 3, R. I.* 70

Button Press

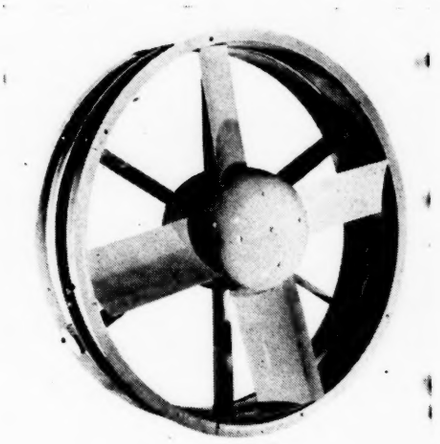
NAME—Helwig button press.
PURPOSE—For binding seams in



sheet metal work.
FEATURES—Tool can be adjusted for different metal thicknesses. Two styles of jaws are available; one straight, and the other at 45° angle for working in close and confined places. Tool can be used parallel with and close to the seam. Jaws are held between two specially tempered steel plates.
MADE BY—*Helwig Mfg. Co., Inc., 422 E. Seventh St., St. Paul, 1, Minn.* 71

Ventilating Fan

NAME—Moore Fan.
PURPOSE—Ventilating fan for use in damp or corrosive vapors.
FEATURES—Fan has a special high slip, slow speed, direct drive motor equipped with greased and sealed ball bearings. Motor is an 18-pole, 375-rpm, 220-volt unit with an input of 700 watts. It is internally cooled by circulating air within the hub of the fan without drawing in outside air. Guide vanes on inlet side of fan reduce tendency of air to corkscrew with the rotation of the blades. Large hub is said to eliminate that portion of blade that



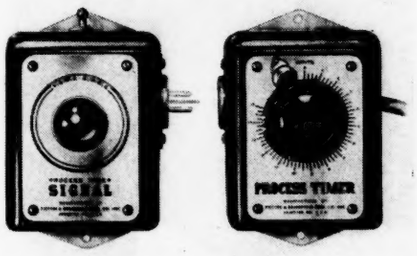
has a low peripheral speed so that backflow of air through the center of the fan is avoided. Fan is constructed of monel metal.
SIZES AND CAPACITIES — Made in sizes from 3- to 5-ft diameters.
MADE BY—*The Moore Company, 544 Westport Rd., Kansas City 2, Mo.* 72

Electric Radiator

NAME—Co-Z-Air electric radiator.
PURPOSE—Space heating.
FEATURES—Units are available in five- and eight-section models operating at 115 volts; in a 12-section model, of the wired-in type, using 220 volts. Five-section model element is rated at 800 watts; the eight-section at 1200 watts, and the 12-section at 2400 watts. The eight- and 12-section models are light enough to be portable.
MADE BY—*Henry J. Morton Associates, Inc., 510 Boulevard Bldg., Detroit 2, Mich.* 73

Process Timer

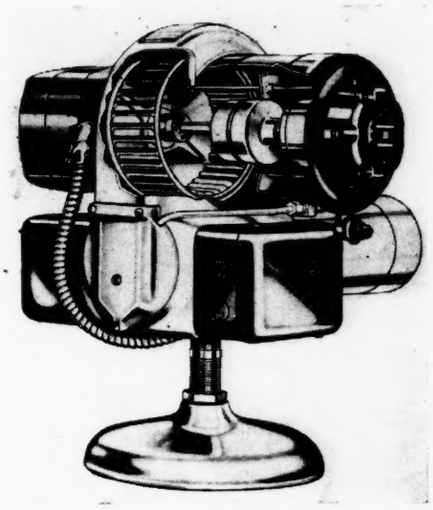
NAME—TA synchronous utility process timer.
PURPOSE — For accurate timing of industrial operations.
FEATURES—Unit has a synchronous motor that actuates a pair of silver contacts. Dial is fitted with an adjustable mechanism so that any desired time interval up to the limit may be preset and thereafter the same time cycle will be repeated at each manual resetting, or the stop may be released and the desired interval set for each operation. Companion piece to this timer is the Type A signal indicator which is housed in a bakelite case. Indicator



contains both a buzzer and a bulls-eye light so that remote control is provided for the timer unit.
SIZES AND CAPACITIES — Standard time cycles are from 0 to 15 min, 0 to 30 min, 0 to 1 hr and 0 to 12 hours.
MADE BY — *Potter & Brumfield Sales Co., Department 247, 549 W. Washington Boulevard, Chicago 6, Ill.* 74

Oil Burner Clutch

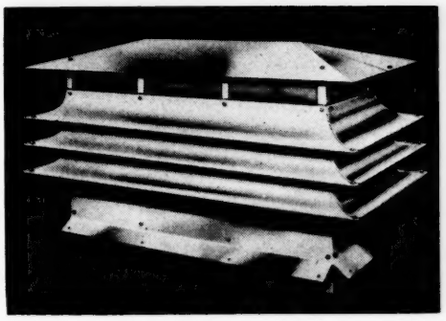
NAME—Economy oil burner clutch.
PURPOSE—To eliminate heavy soot deposits and to decrease fuel oil consumption.
FEATURES—Oil burner motor shaft is in two sections with the clutch separating the pump from the fan and motor. Starting the burner motor simultaneously sets the air fan in motion. An instant later, when the fan is delivering a sufficient amount of air for even combustion, the clutch engages the fuel pump by centrifugal force. When the burner is turned off, the fuel



pump is the first to stop operating. The fan keeps rotating for several seconds after the flame has ceased so that there is complete combustion of the last drop of fuel without smoke. Makers claim that tests of this burner with the Economy clutch showed fuel savings from 10.9 to 24.5% over previous figures.
MADE BY—*Gilbert & Barker Mfg. Co., West Springfield, Mass.* 75

Roof Ventilators

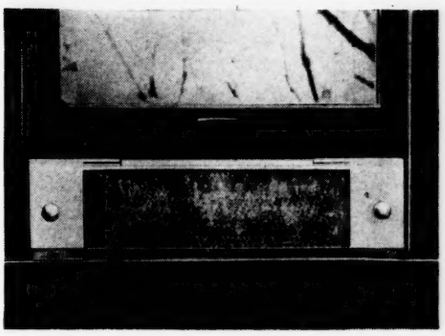
NAME—Airjet ventilators.
PURPOSE—Induced ventilation.
FEATURES—Unit has no moving



parts. Makers claim that regardless of wind direction or turbulence caused by obstructions, down drafts and stagnant air are eliminated. Units are machine made and come in knock-down condition.
SIZES AND CAPACITIES—Six sizes with throat areas ranging from 12 x 12¾ in. to 24 x 72¾ in. Caps are available in 4 and 6-in. diameter throat dimensions.
MADE BY—*C. R. Gelert Co., 35 No. Raymond Avenue, Pasadena 1, Calif.* 76

Filter-Ventilator

NAME—Badgaire filter-ventilator.
PURPOSE — For admitting filtered air into rooms.
FEATURES—Unit is made of aluminum and has an especially designed filter medium for obtaining high ventilating efficiency with low air resistance. Rubber gaskets on top, bottom and sides provide an air seal when inserted in window. Sliding extension wings with holding knobs offer 6 in. extension beyond the basic length of the unit. Oil coated filter can be easily cleaned and then recoated with a filter adhesive applied by a common house-



hold sprayer. Rain and snow are prevented from entering the room.
SIZES AND CAPACITIES—Three sizes available to fit windows from 22 to 40 in. wide and 6 in. high.
MADE BY — *Badger Corporation, East Brown Street, Milwaukee 12, Wis.* 77

Rust Prevention

NAME—Pennsalt's RI-50.
PURPOSE—To prevent corrosion of various metals for short periods.
FEATURES — Rust-preventing solution is applied to various metals before metal is painted or enameled or between machine operations. Product is an inorganic salt mixture used in water solution to give temporary rust protection on metal parts during processing. It is designed to protect metals for short periods such as after cleaning or prior to painting and enameling. It requires no rinsing before painting.
MADE BY—*Pennsylvania Salt Mfg. Co., Philadelphia, Pa.* 78

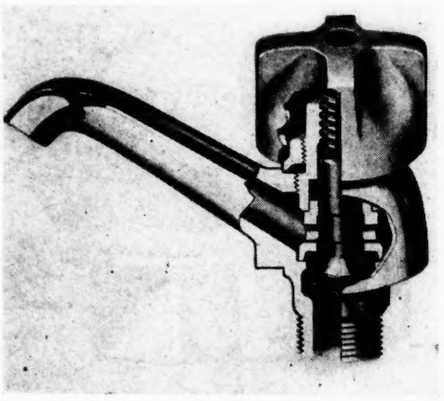
Air Recovery Panel

NAME—Dorex type G panel.
PURPOSE—Air recovery unit for recirculated air.
FEATURES—Unit illustrated is designed for passenger railway cars. One-half of the recirculated air in a car is converted to fresh air through an activated carbon air recovery panel and this is added to a quantity of outdoor air so that each passenger receives 23 cfm with odors held down below point

of perception. Panel is made of lightweight metal and contains a battery of perforated tubes holding activated carbon.
LITERATURE AVAILABLE — Twelve-page folder.
MADE BY—*W. B. Connor Engineering Corp., 114 E. 32nd St., New York 16, N. Y.* **79**

Faucet

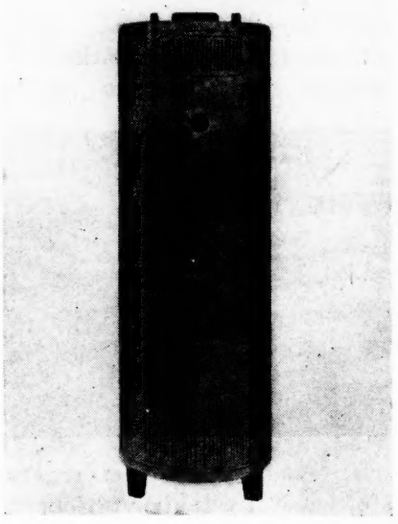
NAME—Crane Dial-ese faucet.
PURPOSE—Non-drip domestic faucet.
FEATURES—Shut-off of the valve mechanism is in the same direction as water flow and this permits the water pressure to aid in closing the valve. Stem threads are lubricated and stem packing is placed between threads and the chamber through which the water flows. Regardless of the shape or design of the line of faucets, the cartridge control unit is standard. Faucets have plastic handles and base coverings



and are produced in a pearl grey shade.
MADE BY—*Crane Co., 836 S. Michigan Ave., Chicago 5, Ill.* **80**

Water Heater

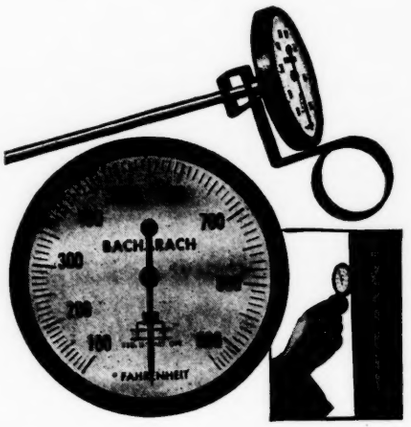
NAME—Rheem series 70 oil storage water heater.
PURPOSE—For general water heater use.
FEATURES—Tank is heavily insulated and all parts completely housed in a white baked enamel steel jacket. Heater operates by gravity oil feed and is regulated by a float



control. It has a low-draft pot-type burner capable of operating with drafts as low as .03 in. of water pressure. A draft regulator is protectively enclosed in the heater jacket.
SIZES AND CAPACITIES—30 and 50 gallons.
MADE BY—*Rheem Manufacturing Co., 570 Lexington Ave., New York, N. Y.* **81**

Thermometer

NAME — Bacharach dial-type thermometer.
PURPOSE — Industrial temperature measurement.
FEATURES—Dial-type thermometer, having temperature range from 100 to 950F, is provided with a slip-on handle when the instrument is in portable use. Handle can be detached when thermometer is to be permanently mounted as an indicating instrument. All-metal construction provides protection from damage resulting through rough



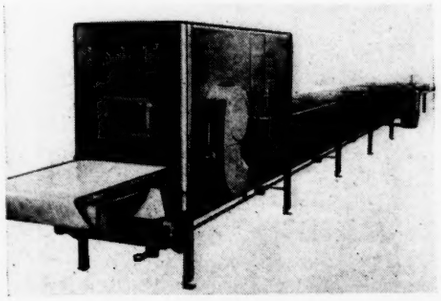
handling. Bi-metallic temperature element does not have pivots, mechanical linkages, or gears and is said to be accurate within 1% of scale range.
LITERATURE AVAILABLE—Leaflet 708.
MADE BY — *Bacharach Industrial Instrument Co., 7000 Bennett St., Pittsburgh 8, Pa.* **82**

Pressure Gauge

NAME—Supergauge.
PURPOSE—Large dial pressure gauge to simplify reading at a distance.
FEATURES—Instrument is designed for heavy duty and the working elements are said to withstand repeated pulsation, vibration, and abnormally high overpressures. Internal parts are made of non-corrosive metals.
SIZES AND CAPACITIES — Made to record pressures ranging from 30 to 10,000 lb per sq in., and in 4½, 6, and 8½ in. diameter dials.
MADE BY — *United States Gauge Division, American Machine and Metals, Inc., Sellersville, Pa.* **83**

Cooling Tunnel

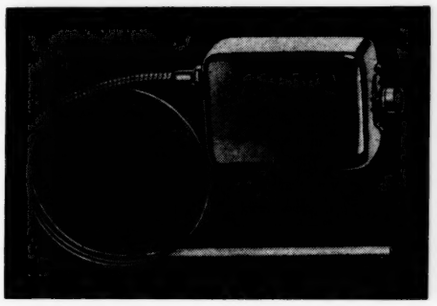
NAME—Hi-Gloss cooling tunnel.
PURPOSE—To produce high gloss on chocolate confections.
FEATURES—Air ducts located at the loading end, discharge cold air into the bottom of the tunnel beneath the conveyor belt and the air is forced through this lower chamber to the unloading end where booster blowers discharge it over the convections in a counter-flow direction. Baffles control the air so that temperature is graduated. Loading ex-



tension is also cooled on the under side so that cooling is obtained through the entire length of the unit. Sectional steel belt carries the glazed belt on which the goods rests. Metal belt absorbs the heat more quickly from the bottoms and it does away with the insulating effect of ordinary canvas belts.
SIZES AND CAPACITIES — Tunnel is made in 8-ft sections with a minimum recommended length of 40 ft. Unit comes in three standard widths, 24, 32 and 42 in.
MADE BY — *J. W. Greer Co., 119 Windsor Street, Cambridge A-39, Mass.* 84

Temperature Control

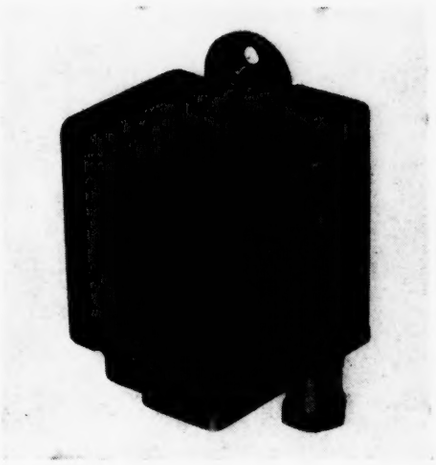
NAME—Type O thermostat.
PURPOSE — For industrial applications of temperature control.
FEATURES—Control is based on a snap-action switch actuated by a liquid filled copper thermal assembly. This assembly has an unvarying and rapid expansion and contraction per degree of temperature change and can be adjusted by either knob and pointer with calibrated dial or by a screw driver. Adjustments cover any 120 or 250F range or from —120 to 600F. Screw driver adjustments cover the entire range from —120



to 180F, from 50 to 350F or from 50 to 600F. Unit can be used for liquids or gases non-injurious to brass, or for metal to metal applications, and can be equipped with ambient temperature compensation.
MADE BY — *United Electric Controls Co., 69-71 A St., Boston 27, Mass.*.....85

Pressure Switch

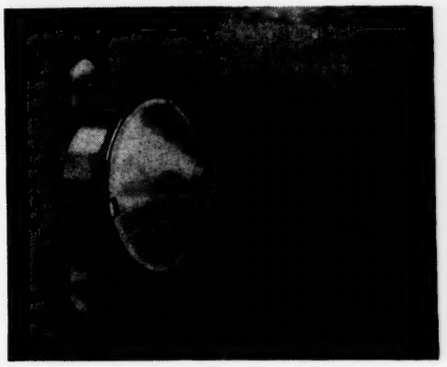
NAME—Model series 320.
PURPOSE—For use in explosive atmospheres.
FEATURES—Various models of this switch provide uniform pressure



control from 25 to 2500 lb per sq in. The minimum differential adjustment is 25 lb per sq in. and the maximum, 200 lb per sq in. Switch is single pole, double throw, 10 amperes at 125 volts a-c. Weight of entire unit including mounting bracket is 3¾ lb. Separate housings for pressure and electrical controls make possible adjustments in the pressure system without disconnecting or exposing circuit.
MADE BY—*Meletron Corp., 950 No. Highland Ave., Los Angeles 38, Calif.*.....86

Snap-Action Thermostat

NAME—Klixon snap-action thermostat.
PURPOSE — Temperature control through a snap-acting disc for use as a high-limit alarm.
FEATURES — Snap-acting disc is mounted in a thermal contact within a sealed housing. This control is non-adjustable. Minimum temperature setting is —10F, maximum, 120F. Minimum cooling temperature differential with contacts



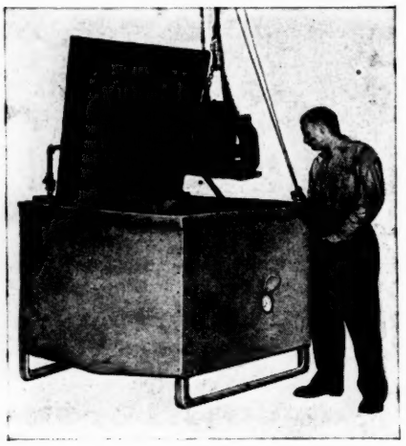
closing on temperature rise is 8F. Minimum heating temperature differential with contacts opening on temperature rise is 10F. Higher settings and wider differentials can be specified.
MADE BY—*Spencer Thermostat Co., Attleboro, Mass.* 87

Electric Heater

NAME—Turvane electric heating unit.
PURPOSE—Air heating in ducts by electric means.
FEATURES—Heat is imparted to the air by the wiping action over heated turning vanes. Vanes are electrically insulated, connected in series, and are provided with terminals for connecting to electric power. Turning vanes are set to reduce the pressure loss at the duct corner by turning only thin layers of air.
SIZES AND CAPACITIES—For cross sections of 3 x 12, 6 x 12, 12 x 12, 12 x 24, 24 x 24, and 24 x 36 in. Heater capacity for these ducts range from 15,000 to 1,240,000 Btu per hr.
MADE BY—*Industrial Chamberheat Laboratories, 2103 Centre St., West Roxbury, Mass.* 88

Cleaning Tank

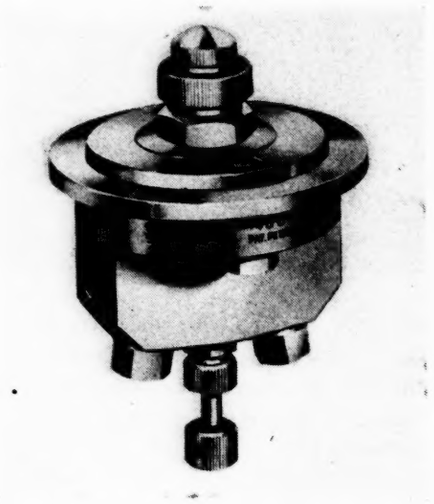
NAME — Aeroil motor block cleaning tank.
PURPOSE — For degreasing large motor units.
FEATURES—Units are insulated and heated from the inside by removable immersion tube system with the burner placed in a well. Manufacturer claims that this unit saves at least 50% fuel costs. Standard equipment includes dial thermometer, removable grilles, scum gutter, sludge drain, draw-off cock, and double-braced hinged covers.



Provision is also made for automatic heat controls for thermostatic temperature regulation from 100 to 550F. Unit is made of 12-gauge steel.
MADE BY—*Aeroil Products Co., 5701 Park Ave., West New York, N. J.* 89

Atomizing Nozzle

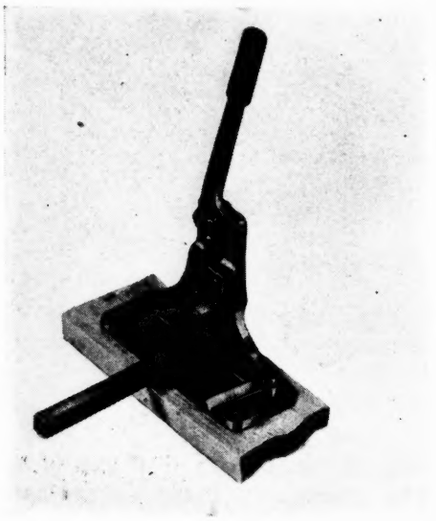
NAME—Pneumatic atomizing nozzle.
PURPOSE — To atomize liquids by steam or air pressure.
FEATURES—Has removable mounting flange which is part of the nozzle assembly, and a monel metal screen or strainer in both the air and water intake chambers. Nozzle is installed by removing the flange from the nozzle and mounting the flange on equipment where required. After the flange is positioned, the nozzle is then bolted to it. Screens are removable for easy cleaning. Nozzles are of either white plated brass or stainless steel



and have a stainless steel needle.
MADE BY — *Spraying Systems Co., 4031 W. Lake Street, Chicago 24, Ill.* 90

Belt Splicer

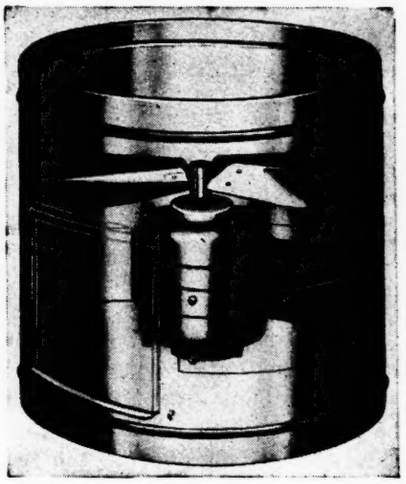
NAME—Paxton-Mitchell belt splicer.
PURPOSE — To provide a quick method for splicing belts.
FEATURES — Designed for use on



2-in. clog V-belts, 1 and 2-in. solid V-belts, and 4 and 5-in. flat belts. Belts are cut and punched in the same operation to match standard splice-fittings. Splicer for flat belts is equipped for handling various arrangements. A simple change in the tool permits splicing of two, three or four-bolt coupling assemblies with the same splicer.
MADE BY — *Paxton-Mitchell Co., Omaha, Neb.* 91

Stack Exhauster

NAME—Wolverine stack exhauster.
PURPOSE—To convert a roof ventilator into a power fan exhaust unit.
FEATURES—Unit is constructed of heavy gauge steel reinforced with a cross member for motor support. Propeller and motor are placed to permit cleaning. Motor is ball bearing directly connected to the fan propeller. On new installations the ventilator base is placed over the roof opening, stack exhauster added, and then ventilator head. Mak-



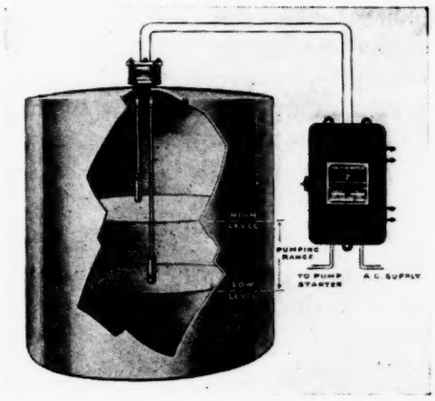
ers claim unit can be installed in existing ventilators.
MADE BY—*Belanger Fan & Blower Co., 2349 W. Lafayette Blvd., Detroit 16, Mich.* 92

Vibration Control

NAME—Viking Vibro-pad.
PURPOSE — For mounting furnace blowers to eliminate vibration.
FEATURES—Pads are designed so that furnace blowers can be set on the floor without bolting or lagging. Dart-shaped head makes it possible to attach the pad to the blower base without screws or bolts and this head pushes through a punched hole in the base and locks itself firmly in position. Pads are molded from oil resistant synthetic rubber and have a resiliency adapted to the frequency and loading characteristics of furnace blowers.
MADE BY—*Viking Air Conditioning Corp., 5600 Walworth Ave., Cleveland 2, Ohio.* 93

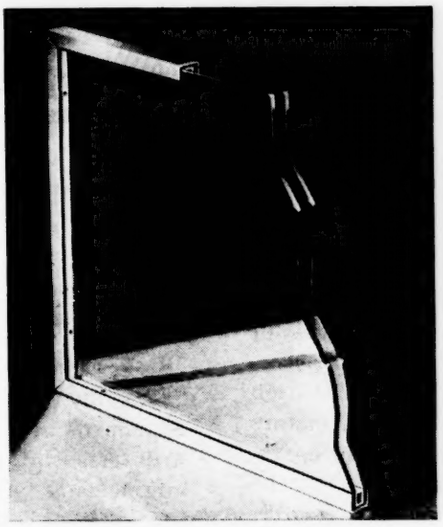
Level Control

NAME — Photoswitch level control series 10.
PURPOSE—Maintains level for electrically conductive liquids.
FEATURES — Contact with liquid is made by a stainless steel probe rod. The probe rods are suspended into the tank from special fittings. The liquid to be controlled makes or breaks contact with the probe and transmits to the control an electrical current at low voltage. This, in turn, controls a power circuit which operates a relay to actuate signals, valves or pumps. Total power consumption is ½ watt. Probe circuit will carry a resistance as high as 3500 ohms.
MADE BY — *Photoswitch Inc., 77 B'way, Cambridge 42, Mass.*.....**94**



Window Insulation

NAME—Twindow.
PURPOSE—Window insulating unit for home and industrial use.
FEATURES—Unit consists of two or more plates of glass enclosing an hermetically sealed air space from ¼ to ½ in. Hollow aluminum tubing separates and holds the glass plates in position. Entire unit is framed with a light-gauge stainless steel channel with the channel legs extending ⅜ in. inward on the surface of the glass from the base around its periphery in order to increase production during installation and use. Where protection against impact and exact thermal control are needed, units can be provided with panes of laminated safety glass.



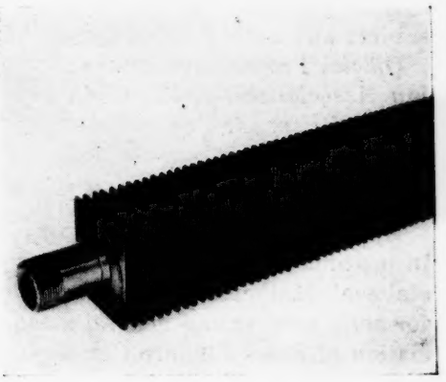
MADE BY—*Pittsburgh Plate Glass Co., 632 Duquesne Way, Pittsburgh, Pa.* **95**

Selector Valve

NAME—Hydro-Aire selector valves.
PURPOSE—Circuit selection.
FEATURES—Makers claim that the valve is light in weight, has low operating torque, is not affected by back pressures, is suitable for temperatures ranging from —65F to 200F, and can be used for any type of liquid. A plug type design is used. Unit can be supplied in small sizes for use in compressed air lines.
SIZES AND CAPACITIES — Sizes are from ⅜ to 1½ in., and in two, three and four-way models.
MADE BY—*Hydro-Aire, Inc., 626 N. Robertson Blvd., Los Angeles, Calif.* **96**

Wall Fin Heater

NAME—Trane wall fin heater.
PURPOSE—General space heating.
FEATURES—Heavy steel fins are attached to a steel pipe by a mechanical expansion process. Elements will be furnished in 3, 4, 5, 6, and 10-ft units or combinations thereof. While the fin and pipe assembly can be used as is, a small cabinet enclosure about 8 in. high may be obtained. The cabinet is said to increase the capacity of the basic coil by 10% besides providing a metal cover for installations where bare units are undesirable. This type radiator is used under windows, under skylights and as a supplement to unit heater systems for factory heating.
SIZES AND CAPACITIES—Two sizes available; one with 38 fins per ft and the other with 50 fins per ft.
MADE BY — *The Trane Company, La Crosse, Wis.* **97**



July, 1946

TO OBTAIN FURTHER INFORMATION ON NEW EQUIPMENT

On the list below, circle the item number of the equipment in which you are interested, using the number found at the end of each item. This service available only to those giving title and business connection.

64	65	66	67	68	69	70	71	72	73	74	75
76	77	78	79	80	81	82	83	84	85	86	87
88	89	90	91	92	93	94	95	96	97		

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Abstracts AND Reviews

NDHA PROCEEDINGS

Committee reports presented at the Cleveland, Ohio, convention of the National District Heating Association are contained in Official Proceedings. Besides the committee reports there are five valuable pages of operating statistics supplied by 59 companies.

It includes reports of committees on steam station engineering, rates and regulations, chemistry, meters and accessories, operating statistics, insurance, research, sales development, and an appendix with the list of members.

As a separate section, the book includes a general subject and author index for 1935-1944.

Official Proceedings of the National District Heating Association—1945. Cloth bound, 6 x 9 in., 259 pages. Price, $5.

INSTALMENT MATHEMATICS

Appliance dealers, contractors and others engaged in instalment payments will find much of value in Instalment Mathematics Handbook by Milan V. Ayres, formerly analyst and general manager, National Association of Sales Finance Companies.

The book is divided into two parts, and all the formulas necessary in time-payment calculations are given in Part I. In the second part are the complete derivations of these formulas with full explanations and examples of standard calculations. While in most cases the first part contains the answers to most questions, many problems cannot be reduced to formulas. Part II is devoted to such cases.

Users of the book require only a knowledge of arithmetic, elementary algebra and a little geometry.

Instalment Mathematics Handbook, by Milan V. Ayres. Cloth bound, 5½ x 8¼ in., 267 pages. Published by The Ronald Press Co. Price, $10.

• • •

ASA YEARBOOK.—For the first time since 1938, the American Standards Association has issued a society year book. Besides giving information about the officers and officials, it includes the constitution and by-laws. The center section has a listing of approved American Standards and projects under development, scopes of the projects, and names of officers and members of active technical committees. Copies free by writing to the association, 70 E. 45th St., New York 17, N. Y.

HEAT PUMP—Heat pump bibliography prepared by the Engineering Research Division of the Southern Research Institute for the Southeastern Electric Exchange. Material is listed which shows the general principle of operation of the heat pump. About 160 references are given. For copies write to the Southern Research Institute, Engineering Research Division, Birmingham 5, Ala.

AMERICAN STANDARDS — At present, 845 American Standards are available through the American Standards Association. These reach into every important engineering field and represent agreement on the part of maker, seller and user groups. A copy of the Catalog of American Standards is free by writing to the association, 70 E. 45th St., New York 17, N. Y.

HEAT TRANSMISSION—Results of a study made at the University of Minnesota by Rowley and Lund to determine Factors Affecting Heat Transmission Through Insulated Walls are available as Bulletin No. 24 of the Engineering Experiment Station. It describes the test apparatus and procedure and the results obtained. While the purpose of this investigation was not to make direct comparisons between different types of installation, it did seek to learn if the methods of application and use of these materials had any appreciable effect on their thermal values in the structure. For copies write to Frank B. Rowley, Director of the Engineering Experiment Station, University of Minnesota, Minneapolis, Minn.

ALASKA COAL—Coal is widely distributed in Alaska with the principal sources 75 miles southwest of Fairbanks, and 40 miles northwest of Anchorage. Engineers from the Bureau of mines and other government departments made a study of the composition and quality of Alaska Coals, conditions of mining and preparation, production, distribution and other major economic facts of the industry. These data are assembled in Bureau of Mines Technical Paper 682, Analyses of Alaska Coals. Copies at 25c each are available through Superintendent of Documents, Government Printing Office, Washington 25, D. C.

COAL FOR DOMESTIC STOKER—Investigations made by the U. S. Bureau of Mines on Burning Bituminous and Subbituminous coals on the Anthracite, Ash-Removal Type, Domestic Stoker are reported in R. I. 3849. Eighteen different trial runs were made with the stoker installed in a commonly used type of hot water boiler. It was found that caking coals are generally unsuitable for this type of stoker, but those caking slightly may be used at some sacrifice in efficiency. Non-caking coals were burned with high efficiency. Write Supt. of Documents, Govt. Printing Office, Washington 25, D. C.

NEWS OF THE MONTH

ELECTRIC HOUSE HEATING

Electricity as fuel is analyzed for two U. S. areas.

One of the "hottest" subjects at the annual meeting of Edison Electric Institute at the Waldorf Astoria, New York, last month was electric house heating discussed from the viewpoint of its possible use in two widely separate climatic areas of the United States. J. H. Polhemus, president of Portland (Ore.) General Electric Co., covered problems and progress in the Pacific Northwest and J. M. Barry, vice-president of Alabama Power Co. discussed the outlook in the South.

• **SOUTH.**—Mr. Barry was especially optimistic about possibilities of the heat pump as an electric heating and cooling unit for his region. A portion of his talk follows:

"It seems to me that in the present state of the art, the conversion of electricity into heat—purely for use in heating the air in a house—economically has two strikes against it. Assuming that the energy comes from a modern steam plant, the electric energy output of the plant would be about 30% of the energy in the fuel. By the time this energy reaches the consumer on the distribution system, the equivalent figure would be about 25%. Thus, there has been lost about three-fourths of the energy in the fuel, which must be recovered in some way if electricity is to be made competitive for house heating.

"On a strictly competitive cost basis for varying fuel prices effective throughout the area, the equivalent electric rate would have to be from 2.0 to 3.5 miles per kwhr. Advantages of electric heat, already mentioned, would justify a somewhat higher price for electricity than this, but the spread is still too great for electricity to be broadly competitive.

• **PEAK SHIFTS.** — "A good many of the utilities in the southern part of the country have already felt, or will soon feel, the impact of summer air conditioning," said Mr. Barry. "Even before the war, peaks of some of these utilities shifted to the summer as a result of air conditioning and refrigeration loads. The summer air conditioning load will continue to grow rapidly, presenting a serious problem to the utility companies. Up to the present time the companies with which I am associated have, however, had very little experience with summer residential air conditioning, but there is no question of the large potentialities of this type of load.

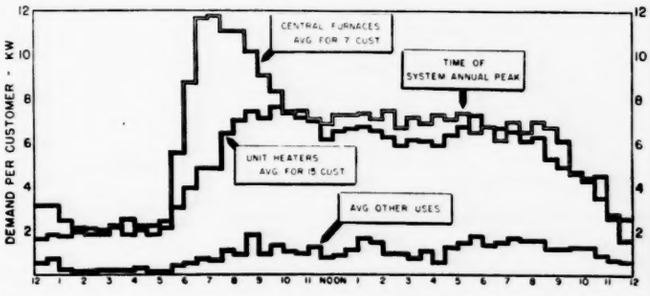
"As announced in March, a contract has been made between the Southeastern Electric Exchange and Southern Research Institute of Birmingham to survey the present status of heat pump development, the plans of manufacturers for its future, the activities of the utilities in this field and their plans for promoting its use. The research staff of the Institute will also compile such practical and theoretical information as may be necessary for evaluating the application of the heat pump to our situation in the Southeast, particularly, and will obtain actual performance data on current installations and sample heat pumps obtained from at least two manufacturers. . . . Philip Sporn has recently suggested that in order to gain experience, an order for 1000 units built according to an agreed specification be placed with a reputable manufacturer, commitments for these units to be made by electric companies throughout the country.

"We believe that the heat pump for year-around air conditioning (summer cooling plus winter heating) could be made competitive, service considered, with coal, oil, and natural gas in the South at rate levels between 1c and 2c per kwhr.

"It is estimated that nearly a million new homes will be built in the South within the next decade and that over 30% of these homes may be considered as active prospects for air conditioning. As these homes should also be prospects for electric heating as well as cooling, the job ahead of us is obvious.

"It is not desirable, in my opinion, to attempt to sell electric power for house heating unless the advantages of such service will be so evaluated by the customer that he will be satisfied without unduly preferential rates. With these considerations in mind, we conclude that the only way to make electric house heating practical in our area is to develop the heat pump to improve its coefficient of performance and otherwise perfect it for the dual job of summer cooling and winter heating; and to make its application economically feasible. Therefore, it seems to me that we should, as an industry, actively work toward these ends."

• **NORTHWEST.** — Mr. Polhemus found conditions in the Pacific Northwest more favorable for the unit resistance and central warm air furnace types of electric heating installation. He mentioned the surplus of hydro-electric power which exists in his region, the influence of the Grand Coulee and Bonneville power projects, and the growing public interest in electric


DEMAND PER CUSTOMER - KW
CENTRAL FURNACES AVG. FOR 7 CUST.
TIME OF SYSTEM ANNUAL PEAK
UNIT HEATERS AVG. FOR 15 CUST.
AVG. OTHER USES
NOON

An all service load record for day of system's maximum yearly peak during Portland General Electric Co.'s house heating tests. December 20, 1945; 32 degree-days; 31F minimum; average connected heating load for central furnaces, 17 kw; for unit heaters, 16 kw. Two upper curves indicate total load including heating. Lower curve indicates residential use before space heating.

house heating, experimental installations of which his company has under test. Extracts from his paper follow:

"Portland General Electric Company felt the beginnings of a definitely forming public demand for full electric house heating some five or six years ago. At the present time there are more than 700 electrically heated dwellings and apartments connected or on order on lines of the company, and our sales departments are receiving 35 to 40 inquiries daily.

"Our proximity to the Bonneville and Coulee projects, the excess Government power available from them and the efforts of BPA administrators to develop usage of these surpluses also has stimulated the demand for electric heat.

"When the first installations began to come on our lines back in 1939 and 1940, our company adopted an experimental attitude toward them and in 1941 opened our existing general residential schedule to house heating installations having a connected load in excess of 6 kilowatts, which we classed as an experimental load requiring prior approval of the company. We accumulated approximately 200 installations prior to the outbreak of the war, which precluded carrying out the tests contemplated at that time. We were, however, able to gather some valuable data during the war years, such as desirable home construction features, satisfactory heating capacities, the practicability of certain equipment types, reactions of users, and similar information.

"Not until September, 1945, were a suitable number of meters obtainable for commencing the load characteristic studies we had planned. At that time we selected 75 test dwellings on the basis of size, location, connected load, and method of heating as a suitable cross section of users.

"From the primary data we shall be able to derive a new house heating rate that will cover our costs plus a reasonable return on investment. As an interim measure pending the outcome of present investigations, the Company last November made effective a new all-electric residential schedule offering customers having ranges and water heaters substantial savings and allowing unlimited house heating subject to a demand charge assessment for demands in excess of 10 kilowatts.

• **TWO METHODS.**—"The two heating methods in general use are unit resistance heaters thermostatically controlled in each room, heating by a combination of radiation and convection, and central warm air furnace heating through ducts by forced convection, also thermostatically controlled. Curves are being developed for each type. These curves seem to indicate fairly positively that the peaks and energy consumed have consistently been less for unit heater systems than for central furnaces. The composite demand measured at the customer's meter at the time of the system peak on December 20 of last year averaged 6.4 kilowatts for central furnaces and 5.3 kilowatts for unit heater systems.

"Also fairly conclusively demonstrated from the data so far at hand is the fact that the cost of power to serve a heating load, under the present kilowatt-year rate at which we presently must purchase Federally-generated power from Bonneville Power Administration, approximately 8½ mills. To this we must add our distribution cost, yet to be determined from our present experimentation. Obviously a resale rate for consumers generated from these costs certainly cannot be lower than the interim schedule now effective (which averages out at approximately 9½ mills) unless the basic conflict between the highly seasonal nature of electric house heating load and the kilowatt-year rate for Federal energy is resolved by a satisfactory modification of the Government's whole rate structure.

The Bonneville administration is aware of this problem and has advised the Company that it is working out a more favorable rate for energy which distributing agencies can resell to house heating customers. They have advised us informally that they have in mind a straight kwhr rate of 4½ mills."

DRY ICE RIFLE

Weapon uses carbon dioxide as propellant.

The use of pressures developed by the evaporation of carbon dioxide from dry ice enclosed in a pressure chamber as a propellant in a .22 gage rifle has been developed to the point of practical application.

• **MECHANISM.**—As a source of pressure, the rifles use dry ice which is encased in a magazine. A half pound of dry ice produces enough gas to shoot 1,000 rounds from a .22. A tube connects the magazine to a conventional barrel. The trigger opens a valve in the tube allowing gas to escape into the barrel and force out the bullet which is merely a rifled slug. The gas expands so rapidly that the slug reaches its highest velocity at the muzzle point.

The low temperature of the escaping gas keeps the gun barrel cool under conditions of rapid fire, and the gun barrel is not corroded by the hot gases produced in conventional firing methods.

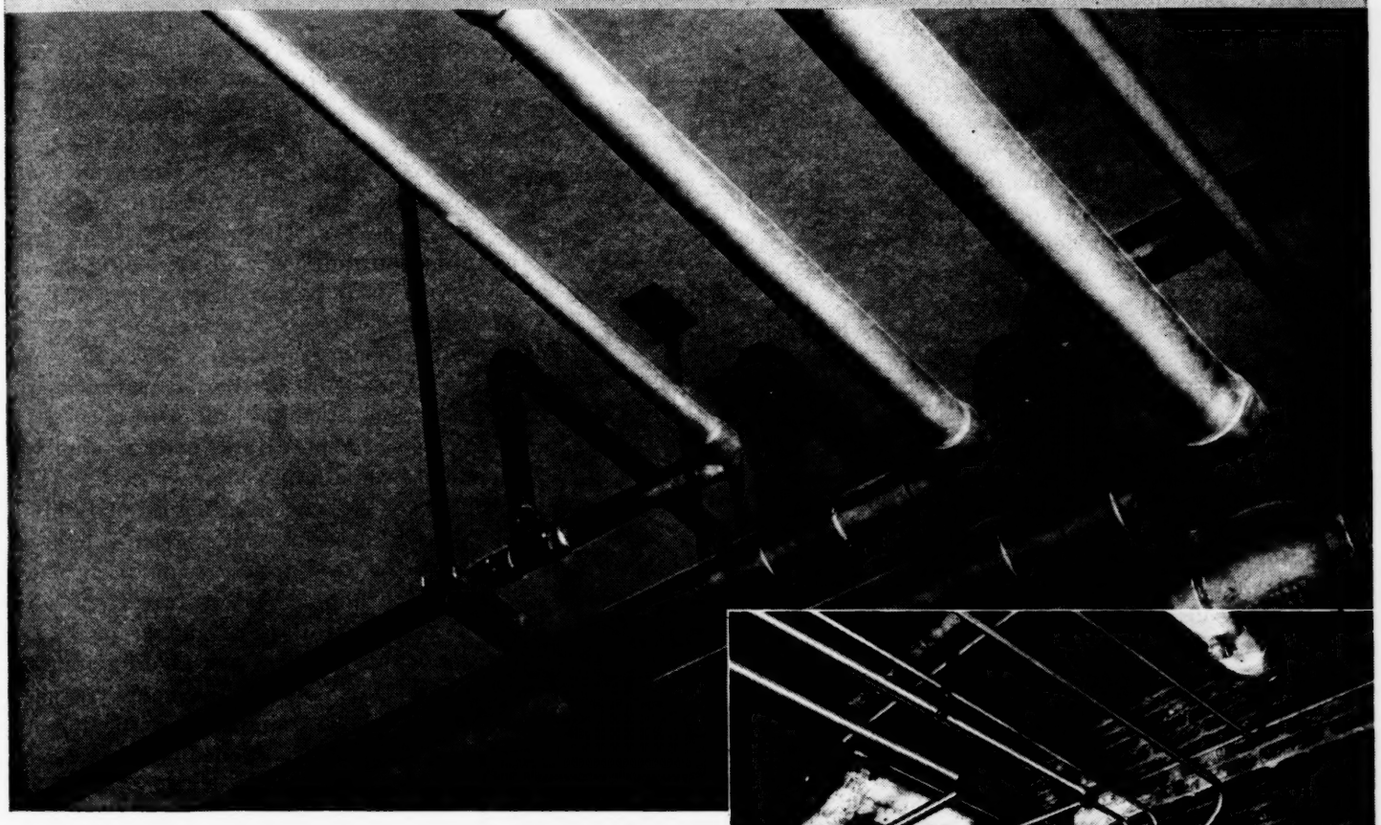
A dry ice .22 maintains a pressure of 1200 lb per sq in. at room temperature. Higher temperatures for larger rifles can be obtained by heating the magazine. The makers claim that, with the magazine holding 200 to 300 lbs dry ice, heavy artillery can be made to fire with the rapidity of a machine gun without serious overheating.

Two associates in the Monner Gun Co., A. J. Monner and Earl Paul, inventors of the rifle, have licensed production rights to Barr Instrument Co. of Moline, Ill.

Dust Removal Cuts Merchandising Losses

The electronic air filter used in the American Sporting Goods Store installation described in lead article in last month's issue under the title given above, is an American Air Filter Co., Inc., unit and not another make as incorrectly reported.

NO JOB IS TOO SMALL...OR TOO LARGE... FOR COPPER



COMPARE the cost of Revere Copper Water Tube, *completely installed,* with that of other materials — and it is clear that you can give your customers lasting value in heating and water lines, and still make attractive profits for yourself. This applies to a modest residential job as it does to a large business building.

Revere Copper Water Tube (99.9% pure copper) is seamless, and is cold drawn with a gun-barrel finish inside. It is deoxidized and is free from flaws and blemishes. Joints are made with either soldered or compression fittings.

Made for water supply, heating, air conditioning and other services in all types of buildings, this tube is stamped with the Revere name and the type at regular intervals. Look for these identification marks—they insure full wall thickness and the close gauge tolerances essential for tight sweated joints.

In making your plans you can specify or install such long-lived Revere materials as Copper Water Tube and Red-Brass Pipe; Sheet Copper for tanks, ducts, pans and trays; Sheet Herculoy for tanks; Dryseal Copper Refrigeration Tube (dehydrated and sealed); Copper oil burner, heat control and capillary tubes.

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FUEL

Coal, oil and gas continue fight for markets while electric space heating moves ahead.

The battle of the fuels goes on with increasing ardor in courtship of the coy consumer.

• **COAL.**—Fundamental objections to the satisfactory use of coal as a domestic or industrial fuel are being rapidly offset by a number of developments, according to M. M. Leighton, Chief, State Geological Survey Division, Urbana, Ill. Mr. Leighton lists improvement in devices for smokeless burning of bituminous coal for the domestic trade as one of the major advances in the claims of coal upon the domestic market. Next in line is the development of smokeless briquets and domestic coke of low ash content. Research in preparation of domestic stoker coals is also named as a factor in the development of the coal market. The expansion of knowledge of coal blending, coking properties, nature of by-products, etc., will aid in the solving of storage, weathering, and handling problems. The Illinois Geological survey will soon issue a progress report on these various factors, especially as they apply to Illinois coals.

Further evidence of the activity of Illinois as a coal producing State is given in the announcement that the University of Illinois will resume a series of conferences on coal utilization, discontinued at the outbreak of the war. H. L. Walker, head of the department of Mining and Metallurgical engineering, has announced that the eighth conference of the series is scheduled for September 18-19 at the University.

The atomic touch is given by Arthur D. Little Co., Inc., investigating a radioactive method of invisible trade-marking of coal so that its origin can be permanently traced. This is accomplished by addition of a radioactive substance during the processing of coal which imparts varying degrees of radioactivity to the coal and can be identified readily with a Geiger counter. So permanent is the radioactive trademark that it remains in the ash sufficiently to allow identification even after combustion has been completed.

• **BRIQUETS.**—A Bureau of Mines report states that packaged coal in the form of compressed briquets has an even broader future because of the possible use of surplus anthracite "fines" along with bituminous coal, for making fuel blocks. As part of a program to encourage the utilization of smaller sizes of anthracite, the Bureau recently investigated the processing of fuel cubes or coal blocks from straight anthracite fines and some blends of anthracite and bituminous coals at the Central Experiment Station at Pittsburgh, Pa. Combustion tests show that although straight anthracite blocks crumble, those made from a mixture of anthracite and soft coal have satisfactory binding qualities and burn without crumbling.

• **GAS.**—A. D. Singh, of the Institute of Gas Technology, when speaking at the annual convention of the Smoke Prevention Association at Columbus, Ohio, expressed the view that known reserves of natural gas are probably insufficient to permanently meet the domestic heating load to a degree that will prove effective in widespread smoke abatement. Mr. Singh also pointed out that while the supply of raw materials for products of manufactured gas is almost inexhaustible, economic and technological aspects of gas manufacturers must be made more favorable before it can be classed as a major, permanent factor in smoke abatement.

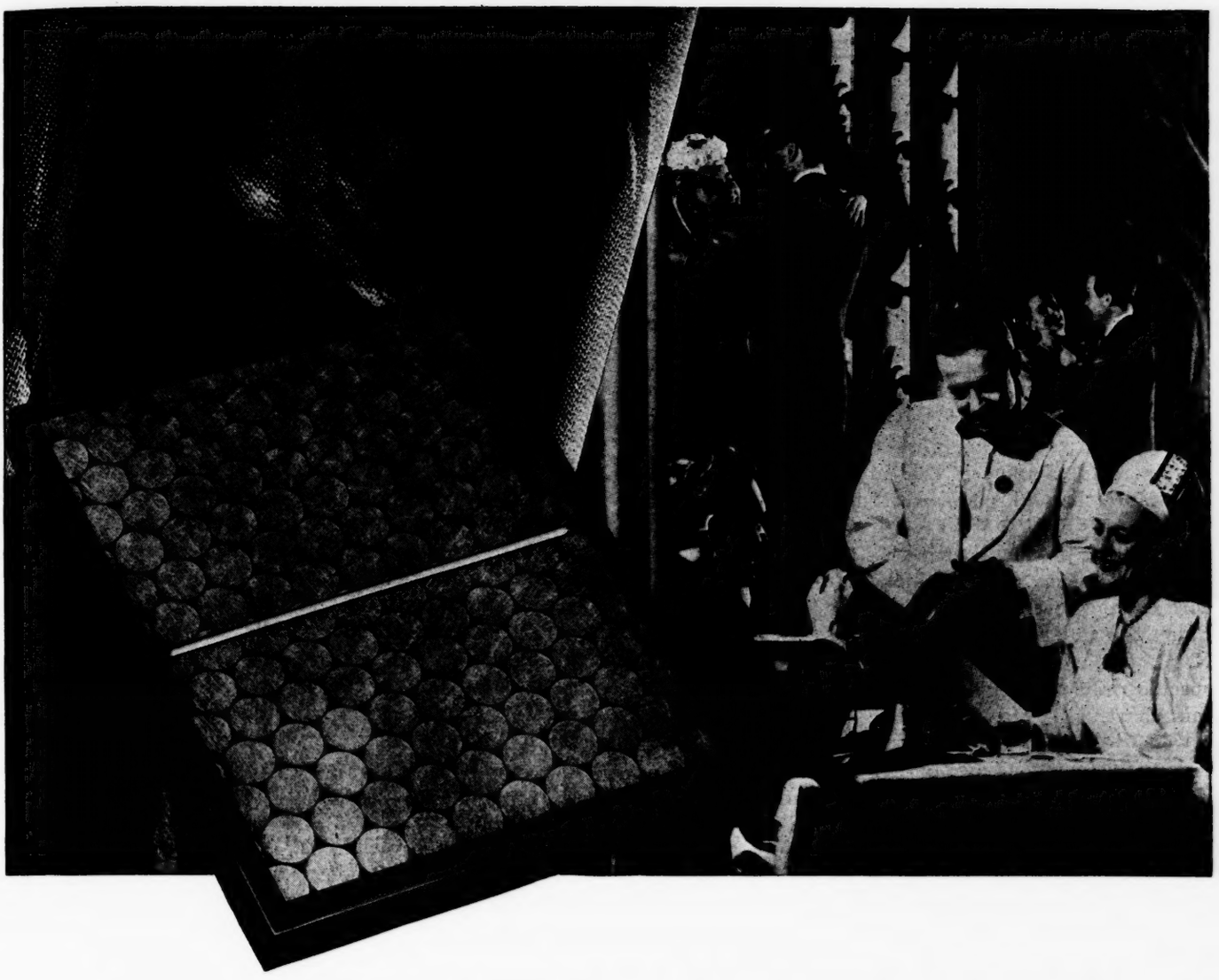
That progress in the solution of gas manufacturing problems is being made is evidenced by results of gas industry research, especially in the development of new production processes. For instance, the fluidization process, used on a large scale in Germany with brown coal, involves the contact of crushed coal with highly super heated steam. Other methods of producing gas from sub-bituminous coal are being developed at the universities of North Dakota and Minnesota (H&V:9:45:p102).

Apparently the building trades, too, are not completely sold on the permanence of the natural gas supply, according to action taken by the Ordnance and Legislation Committee of the Minneapolis Council in killing a bill which would have allowed erection of houses with small flues instead of conventional chimneys. Local fuel and building trade groups argued against the measure on the ground that a chimney designed only for natural gas was unfair to buyers of homes in the event of a failure of gas supply.

• **OIL.**—Oil burner manufacturers are girding for the domestic battle with various improvements in mechanical equipment and new emphasis on the importance of installation techniques. Pioneer in this direction is Williams-Oil-O-Matic Co., in its factory training service program. The school is set up in the company's Bloomington, Ill., plant and enrolls about 20 men per week for a 54 hour course in installation and service.

J. W. Schulz reporting in "Fuel Oil and Oil Heat" shows that progress is being made in equipment designed to solve some oil burner problems. However, progress in this direction is not universal, according to Mr. Schulz, for he says that a survey of thousands of installations revealed many inefficient or poorly installed burners. The goal of the industry is sootless, silent burning on every installation, but this, says Mr. Schulz, is not something which the industry as a whole can achieve overnight.

• **ELECTRICITY.**— Some of the problems involved in the use of electricity as a domestic fuel are discussed in another article in this section. Another detail is the report that the Muncie Gear Works, Inc., in Muncie, Ind., has developed a compact, waist-high heat pump which extracts heat from water for the heating cycle. A source of water at around 50F is required. Plans are for 100 trial installations to be completed this year. The company claims the unit is efficient enough to compete with coal and oil in the home heating field. A one-story home in Muncie was equipped with one of these units (called Marvair) and kept at 78F night and day from November, 1944 to June 11,



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—a FIBERGLAS product

1945, consuming a total of 8,070 kilowatt hours of electricity.

A similar unit manufactured by Drayer-Hanson using air as the heat transfer medium is called Airtopia.

ASRE PAPERS

Summary of some of the papers presented at the St. Paul spring meeting.

Considerable interest was shown in a symposium on air conditioning that was part of the program for the summer convention of the American Society of Refrigerating Engineers held in St. Paul, Minn., June 2-5. More than 400 persons attended.

• **PALMATIER AND WILE.**— A chart for solving air conditioning problems within a limited range of barometric pressures and in which there is a small pressure change in the apparatus was described by E. P. Palmatier and D. D. Wile of Carrier Corp., Syracuse, N. Y. In their paper, the authors demonstrated how specific problems could be solved through the use of this chart.

• **KERSHAW.**—In his paper, "Designing Air Conditioning Systems for Low Maintenance," M. G. Kershaw, Heating, Ventilating and Air Conditioning Engineer, E. I. du Pont de Nemours & Co., pointed out that maintenance is a reflection of the amount of thought included in the original design. Systems must be turned over to the operating men in first class condition. The paper was based on du Pont practices.

• **JONES.**—Robert L. Jones of the Airtemp Division, Chrysler Corp., Dayton, Ohio, read a paper on "Quality Application Practices in the Packaged Air Conditioning Field." He covered the question of design, problems of the salesman or field engineer, and the important matter of servicing.

• **MEEK**—George W. Meek, Consulting Engineer, Syracuse, N. Y., presented a paper on "An Analysis of Multi-Room Air Conditioning Systems." His paper included an extensive table on comparison of individual room air conditioning systems for large multi-room buildings. It included fan type units, self-contained type units, induction type units, and central duct systems.

• **WOOD.**—"Quality Air Conditioning Standards for Large Spaces and Industrial Installations" were described by F. C. Wood, Manager, Air Conditioning Department, York Corp., York, Pa. He touched on control in the textile industry, and atmospheric control for industrial processes. Whereas formerly special floors or sections of large buildings were air conditioned, now size is no handicap and complete buildings are air conditioned.

• **WILKES.**—Prof. Gordon B. Wilkes of the Massachusetts Institute of Technology spoke on "Thermal Conductivity, Expansion and Specific Heat of Insulators at Extremely Low Temperatures." Insulating materials studied included glass fibre board, expanded glass block, vegetable fibre board, mineral wool board, expanded rubber board, shredded redwood bark and reflective coated steel insulation. With the reflective insulation, results show that conductance with downward heat flow varies with the mean temperature while with upward flow, it varies with the temperature difference and is independent of the mean temperature except for very small temperature drops.

• **FENN.**—In his paper "Quality Air Conditioning—a Summary of Application Practices," G. Titus Fenn of Charles S. Leopold, Philadelphia, covered such topics as dehumidifying equipment, duct design, odor control, filtration of air, air outlets, reheat control, outside air capacity, zoning and maintenance.

• **ASHLEY.**—"A Method of Analyzing Finned Coil Heat Transfer Performance" was described by C. M. Ashley, Carrier Corp., Syracuse, N. Y. He presented a method by which the overall coefficient of resistance to heat transfer of a finned coil may be broken down into its components by means of a combination of simple analytical and test procedures. Numerous applications to which the results can be supplied were included.

• **KAYAN.**—Carl F. Kayan, Columbia University, spoke on "Temperature Patterns and Heat Transfer for a Wall Containing a Submerged Metal Member." Besides describing the experimental procedure, there were a number of charts for estimating temperatures from isopotential lines. Some examples were included on the use of his findings.

• **NEW CHAPTERS.**—Action leading to the forming of new ASRE sections in Atlanta, Buffalo and the Dallas-Ft. Worth areas was stimulated by a trip made to these cities just previous to the St. Paul convention by David L. Fiske, secretary of the society. In each city a meeting was held which lead to the decision to apply to the ASRE Council for a charter. This action was approved by the council at its recent meeting in St. Paul.

ENGINEERING SCHOOL

University of Buffalo advances M. E. department to full division.

Establishment of a School of Engineering at the University of Buffalo and the appointment of Prof. Paul E. Mohn as its dean, has been announced by Chancellor Samuel P. Capen.

• **NEW BUILDING.**—The new school will be housed in the engineering building now under construction on the North Main Street campus (H&V:12:45:p:114).

• **DEAN.**—Dean Mohn, 44 years old, is a graduate of Pennsylvania State College and the University of Illinois. He taught at Rensselaer Polytechnic Institute from 1922 to 1925 and at the University of Illinois from 1925 to 1944.

One of his outstanding industrial contributions was the designing of a new line of domestic warm-air furnaces for the Lanzenberg Mfg. Co. of St. Louis, Mo., in 1930. He developed new methods of design which have since been generally adopted in the industry.

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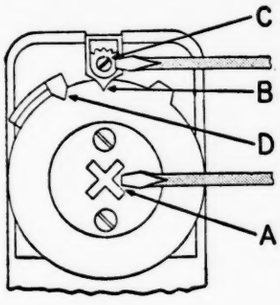
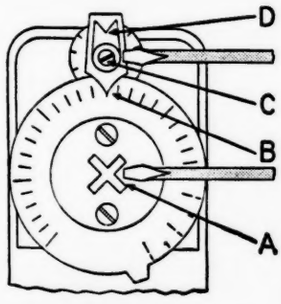
● ADJUSTMENT OF TEMPERATURE CONTROLS



Insert screwdriver at point "A" and turn dial until indicator "B" points to the temperature at which the control is to open the circuit. Then turn screw "C" until you get the desired differential as indicated by the difference in temperature between points "B" and "D."

● ADJUSTMENT OF PRESSURE CONTROLS



Insert screwdriver in slot "A" and turn large dial until indicator "B" points to the desired pressure reading. Then insert screwdriver at point "C" and turn small dial until indicator "D" points to the differential wanted.

White-Rodgers Temperature and Pressure Controls are so easy to adjust that a screwdriver is the only tool needed to do the job. The differential is "mechanical" and once set (as shown in the diagrams) remains constant throughout the entire range of the control. This feature gives every control a wider variety of applications, yet each is individually adaptable to the user's particular requirements.

These are only two of the many features of the complete White-Rodgers line. Simplicity of installation and dependability of performance, plus unwavering accuracy and attractive appearance have made White-Rodgers Controls standard equipment with leading manufacturers in the heating, air-conditioning and refrigeration fields.

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Degree-Days for May, 1946

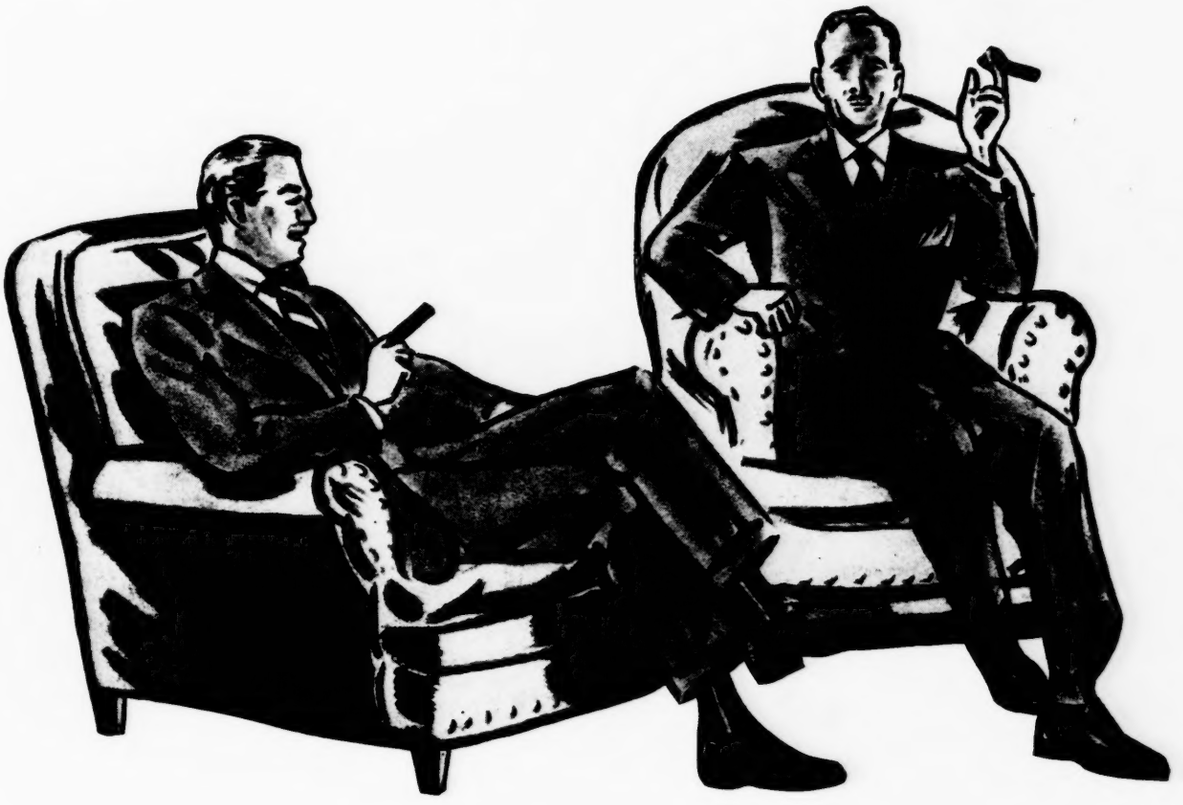
HEATING AND VENTILATING'S 19TH YEAR OF PUBLICATION OF MONTHLY DEGREE-DAY DATA

CITY	MAY			CUMULATIVE, SEPTEMBER 1 TO MAY 31			HEATING SEASON[1]
	1946	1945	NORMAL	1945-46	1944-45	NORMAL	NORMAL
Abilene, Texas	27	37	0	2388	2484	2061	2061
Albany, New York	312	360	183	6778	6793	6580	6580
Albuquerque, New Mexico	76	41	40	4242	4303	4298	4298
Alpena, Michigan	509	564	465	7635	7661	8127	8299*
Anaconda, Montana	549	531	517	7508	7882	8010	8357**
Asheville, North Carolina	112	188	71	3941	3780	4232	4232
Atlanta, Georgia	22	106	0	2778	2846	2890	2890
Atlantic City, New Jersey	70	209	220	4466	4761	5176	5176
Augusta, Georgia	4	36	0	2104	2099	2161	2161
Baker, Oregon	364	391	431	6726	6607	6950	7163
Baltimore, Maryland	73	128	22	4016	4214	4533	4533
Billings, Montana	396	408	316	6373	6823	7059	7119
Binghamton, New York	277	340	254	6310	6547	6808	6808
Birmingham, Alabama	13	74	0	2648	2632	2352	2352
Bismarck, North Dakota	435	480	338	8710	8414	9147	9192
Block Island, Rhode Island	343	372	378	5530	5608	5689	5788
Boise, Idaho	230	265	236	5626	5643	5552	5552
Boston, Massachusetts	237	313	245	5702	5703	6045	6045
Bozeman, Montana	559	513	471	7630	7724	8195	8521**
Buffalo, New York	312	447	335	6460	6675	6810	6822
Burlington, Vermont	365	405	273	7607	7610	7511	7514
Butte, Montana	566	525	502	8028	8154	7926	8272
Cairo, Illinois	51	125	0	3417	3809	3909	3909
Canton, New York	387	449	334	7894	7911	8020	8020
Charles City, Iowa	327	381	224	7165	7315	7588	7588
Charleston, South Carolina	0	11	0	1737	1784	1769	1769
Charlotte, North Carolina	36	90	0	2886	3019	3120	3120
Chattanooga, Tennessee	24	107	0	3175	3380	3118	3118
Cheyenne, Wyoming	592	453	446	6912	7236	7340	7466
Chicago, Illinois	279	331	254	5804	5772	6018	6077
Cincinnati, Ohio	99	196	0	4346	4932	4684	4684
Cleveland, Ohio	247	360	220	5603	5929	6155	6155
Columbia, Missouri	144	218	22	4464	4934	4922	4922
Columbia, South Carolina	10	59	0	2269	2325	2364	2364
Columbus, Ohio	169	241	87	5020	5351	5398	5398
Concord, New Hampshire	351	405	298	7435	7241	7299	7353
Concordia, Kansas	211	181	65	4746	5014	5315	5315
Dallas, Texas	18	32	0	2103	2232	2256	2256
Davenport, Iowa	222	289	118	5881	5965	6289	6289
Dayton, Ohio	214	282	81	5462	5723	5264	5264
Denver, Colorado	405	253	267	5224	5509	5874	5874
Des Moines, Iowa	224	291	118	5875	6099	6384	6384
Detroit, Michigan	273	397	226	6088	6295	6490	6490
Devils Lake, North Dakota	452	592	424	9869	9183	9874	9970
Dodge City, Kansas	189	191	47	4499	4973	5035	5035
Dubuque, Iowa	240	331	149	6393	6522	6790	6790
Duluth, Minnesota	548	606	521	9103	8849	9267	9443
Eastport, Maine	525	581	543	7708	7413	7941	8520**
Elkins, West Virginia	234	319	177	5513	5737	5697	5697
El Paso, Texas	5	1	0	2538	2546	2428	2428
Ely, Nevada	519	496	—	7563	7760	—	—
Erie, Pennsylvania	288	399	257	5757	5944	6273	6273
Escanaba, Michigan	504	584	490	8026	8202	8608	8771*
Evansville, Indiana	122	190	0	4284	4621	4244	4244
Fort Smith, Arkansas	50	81	0	3062	3075	3147	3147
Fort Wayne, Indiana	275	390	130	6120	6439	5925	5925
Fort Worth, Texas	28	32	0	2155	2257	2148	2148
Fresno, California	16	24	0	2435	2690	2334	2334
Galveston, Texas	0	2	0	1045	976	1016	1016
Grand Junction, Colorado	179	86	118	5477	5000	5548	5548
Grand Rapids, Michigan	278	382	174	6211	6234	6535	6535
Green Bay, Wisconsin	387	448	322	7586	7471	7825	7825
Greensboro, North Carolina	77	134	0	3685	3773	3529	3529
Greenville, South Carolina	37	90	0	3052	3009	3380	3380
Harrisburg, Pennsylvania	125	202	90	5098	5215	5375	5375
Hartford, Connecticut	262	292	202	6168	6114	6036	6036
Hatteras, North Carolina	9	48	0	2407	2662	2571	2571
Havre, Montana	409	405	369	7470	8010	8556	8700
Helena, Montana	458	431	402	7058	7777	7663	7898
Houston, Texas	0	11	0	1188	1163	1157	1157
Huron, South Dakota	366	397	267	7683	7436	8004	8004
Indianapolis, Indiana	161	235	59	4987	5230	5298	5298
*Kansas City, Missouri	136	211	6	4362	4727	4956	4956
Kewanee, Illinois	267	269	133	5800	5785	6129	6139
Knoxville, Tennessee	36	137	0	3354	3592	3670	3670
La Crosse, Wisconsin	315	407	183	7417	7163	7322	7322
Lander, Wyoming	498	368	428	7404	8494	7812	7947

[1]Figures in this column are normal totals for a complete heating season, September to June, incl.

Figures in this table, with nine exceptions, based on local weather bureau reports. Exceptions are Utica, Lewiston, Kewanee, Sioux City, and Jackson, figures for which are furnished through the courtesy of Coke Sales Department, Central New York Power Corp., Utica, N. Y.; Norman E. Ross, Bursar, Bates College, Lewiston, Me.; J. M. Hartman, Engineering Department, Kewanee Boiler Corp., Kewanee, Ill.; Alfred R. Wagstaff, Engineer, Sioux City Foundry and Boiler Co., Sioux City, Iowa, and H. M. Ludlow, Box 1368, Jackson, Miss., respectively; Anaconda, Bozeman, Butte and Livingston, Mont., through the courtesy of the Montana Power Company.

[Table concluded on page 100]



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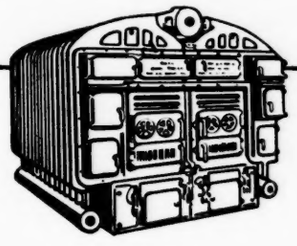

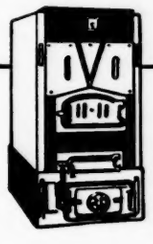

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CAST-IRON BOILERS

THE H. B. SMITH CO., INC., WESTFIELD, MASS. Offices and Representatives in Principal Cities

Degree-Days for May, 1946 (Concluded)

HEATING AND VENTILATING'S 19TH YEAR OF PUBLICATION OF MONTHLY DEGREE-DAY DATA

CITY	MAY			CUMULATIVE, SEPTEMBER 1 TO MAY 31			HEATING SEASON[1]
	1946	1945	NORMAL	1945-46	1944-45	NORMAL	NORMAL
Lansing, Michigan	337	455	229	6677	6882	7048	7048
Lewiston, Maine	359	425	344	7703	7483	7662	7707
Lincoln, Nebraska	218	266	99	5185	5534	5999	5999
Little Rock, Arkansas	32	76	0	2853	3046	2811	2811
Livingston, Montana	522	511	405	6748	7132	7043	7205
Los Angeles, California	126	110	90	1417	1512	1504	1504
Louisville, Kentucky	89	171	0	3926	4342	4180	4180
Lynchburg, Virginia	107	162	0	4057	4220	3980	3980
Jackson, Miss.	2	40	0	2075	2079	0	—
Macon, Georgia	7	41	0	2176	2153	2201	2201
Madison, Wisconsin	291	380	236	6993	7017	7429	7429
Marquette, Michigan	528	649	496	8011	7973	8464	8693*
Memphis, Tennessee	29	94	0	2973	3212	2950	2950
Meridian, Mississippi	3	54	0	2111	2245	2160	2160
Milwaukee, Wisconsin	385	461	350	6808	6892	7206	7245
Minneapolis, Minnesota	320	403	236	7666	7569	7850	7850
Modena, Utah	338	340	350	6226	6405	6520	6562
Montgomery, Alabama	0	32	0	1925	1835	1884	1884
Nantucket, Massachusetts	(a)	344	384	(a)	5478	5834	5957
Nashville, Tennessee	56	130	—	3398	3678	3507	3507
New Haven, Connecticut	283	313	223	5941	5904	5895	5895
New Orleans, Louisiana	0	2	0	1108	987	1024	1024
New York, New York	154	204	155	4885	4952	5347	5347
†Nome, Alaska	1454	1386	1443	12342	11340	12085	14580**
Norfolk, Virginia	48	73	0	3063	3234	3350	3350
North Head, Washington	369	376	422	4695	4361	4693	5452**
North Platte, Nebraska	290	290	199	5578	5970	6366	6366
Oakland, California	266	263	205	3125	2974	2870	3143**
Oklahoma City, Oklahoma	58	97	0	3133	3443	3613	3613
Omaha, Nebraska	198	266	84	5572	5914	6131	6131
Oswego, New York	355	475	357	6695	6772	7025	7088
Parkersburg, West Virginia	116	211	53	4463	4964	4775	4775
Peoria, Illinois	231	312	217	5793	5985	6242	6109
Philadelphia, Pennsylvania	101	165	68	4441	4578	4855	4855
Phoenix, Arizona	0	0	0	1479	1555	1405	1405
Pittsburgh, Pennsylvania	148	235	78	4845	5146	5235	5235
Pocatello, Idaho	379	311	332	6789	6805	6595	6655
Portland, Maine	415	480	666	7543	7375	6771	7218
Portland, Oregon	137	180	245	4951	3984	4379	4469
Providence, Rhode Island	206	250	251	5461	5400	6015	6015
Pueblo, Colorado	278	178	186	5292	5567	5514	5514
Raleigh, North Carolina	41	98	0	3125	3253	3234	3234
Rapid City, South Dakota	466	425	344	6521	7079	7088	7118
Reading, Pennsylvania	123	197	96	4910	5068	5389	5389
Red Bluff, California	29	77	—	2716	2673	—	—
Reno, Nevada	289	359	366	5609	5873	5802	5892
Richmond, Virginia	64	110	0	3613	3702	3695	3695
Rochester, New York	309	434	260	6605	6851	6732	6732
Roseburg, Oregon	186	204	267	3956	3992	4314	4428
Roswell, New Mexico	39	26	0	3193	3308	3484	3484
Sacramento, California	67	110	53	2619	2689	2653	2653
St. Joseph, Missouri	171	227	16	4774	5086	5161	5161
St. Louis, Missouri	112	191	0	4136	4599	4585	4585
Salt Lake City, Utah	252	202	236	5640	5342	5555	5555
San Antonio, Texas	6	6	0	1514	1549	1202	1202
San Diego, California	48	76	115	1365	1492	1639	1645
Sandusky, Ohio	232	349	183	5571	5900	6208	6208
San Francisco, California	293	297	264	2655	2627	2681	3264**
Sault Ste. Marie, Michigan	548	626	502	8778	8759	8950	9285**
Savannah, Georgia	0	15	0	1581	1480	1490	1490
Scranton, Pennsylvania	212	290	171	5815	6121	6129	6129
Seattle, Washington	166	203	316	4150	4045	4695	4934**
Sheridan, Wyoming	460	399	403	6811	7264	7888	8008
Shreveport, Louisiana	6	30	0	2039	2097	1938	1938
Sioux City, Iowa	267	344	164	6545	6668	6898	6898
Spokane, Washington	244	250	285	6034	6002	6274	6355
Springfield, Illinois	147	220	56	4861	5657	5373	5373
Springfield, Missouri	151	234	12	4218	4640	4428	4428
Syracuse, New York	299	391	267	6619	6748	6881	6893
Tacoma, Washington	203	244	332	4543	4456	4883	5181**
Terre Haute, Indiana	148	212	0	4757	5025	4872	4872
Toledo, Ohio	268	394	180	6079	6485	6077	6077
Topeka, Kansas	136	208	34	4347	4717	4969	4969
Trenton, New Jersey	127	182	81	4875	4990	4933	4933
Utica, New York	326	382	253	7561	7170	6796	6796
Valentine, Nebraska	391	367	273	6357	6970	7039	7039
Walla Walla, Washington	137	138	171	4418	4636	4808	4808
Washington, D. C.	77	149	25	4028	4257	4626	4626
Wichita, Kansas	136	190	0	4113	4502	4673	4673
Williston, North Dakota	447	507	362	8744	8488	9269	9323
Winnemucca, Nevada	304	299	324	5894	6214	6274	6427**
Yakima, Washington	81	144	186	5039	5105	5599	5599

†Nome data are for April.
(a) Data not available.

*Includes August.
**Includes July and August.

[1]Figures in this column are normal totals for a complete heating season, September to June, incl.

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Hit the Bull's-eye for GREATER PROFITS

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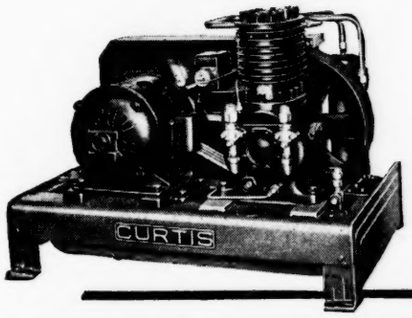

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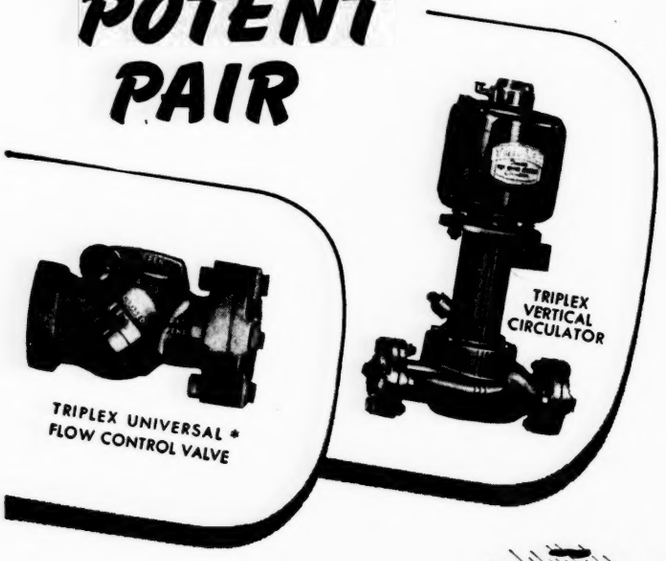

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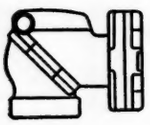

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NEW CATALOGS

Radiant Heating Booklet

A new 20-page booklet entitled "Radiant Heating," covering the use of copper tube in radiant heating systems, has been published by the Copper & Brass Research Association. Non-technical in nature, this booklet discusses the history and development of radiant heating and enumerates some of the advantages claimed for this system in modern construction. Numerous examples of successful installations of all types from coast to coast, employing copper tube with soldered fittings, are cited and illustrated in this publication.—*Copper & Brass Research Association, 420 Lexington Ave., New York 17, N. Y.* 40

Activated Carbon

A new booklet, "Columbia Activated Carbon," Form 4712, is of interest to those who require activated carbon for solvent recovery, for purification of air or gas, or as a catalyst carrier. Several types and grades of activated carbon for specific uses are described. Specifications and suggested applications are presented in this booklet.—*Carbide and Carbon Chemicals Corp., 30 East 42nd St., New York 17, N. Y.* 41

High Pressure Centrifugal Pumps

A new bulletin, No. C-945, covers horizontal split case, multi-stage, high pressure centrifugal pumps. These pumps can be used with motor, steam turbine or engine drives. They are designed for high pressure boiler feeding, skyscraper and industrial water supply, and handle liquids from 75 to 100 lb per sq in.—*Economy Pumps, Inc., Hamilton, Ohio* 42

Electric Draft Control

A 16-page bulletin "How To Cut Your Fuel Bill" presents diagrams showing how to stop combustion fuel losses. Different models of electric draft controls are illustrated. Data are given on how electric draft controls operate with stokers, oil and gas burners.—*Campbell Engineering Co., Appleton, Wis.* 43

Hot Water Specialties

To round out a line of heating supplies, Catalog 50 covering a new line of hot water heating specialties describes circulating pumps, flow control valves, air eliminators, tees, tanks, indirect heaters, valves, controls, and gauges. — *Marsh Heating Equipment Co., 2120 Southport Ave., Chicago 14, Ill.* 44

Steam Jet Air Ejectors

New catalog illustrates the line of Conseco steam jet air ejectors, showing various applications for power plant, industrial, and marine use. Contains engineering data, specifications, graphs, and tables to help select suitable equipment.—*Condenser Service & Engineering Co., Inc., Hoboken, N. J.* 45

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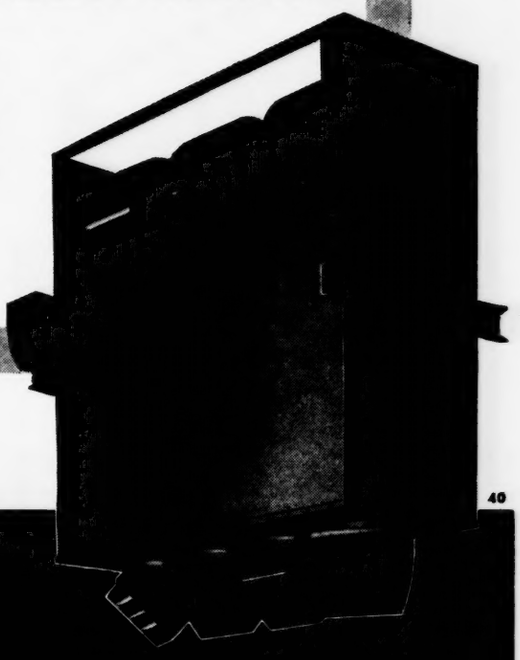
The Airtherm Warm Air Heater is factory assembled. No on-the-job assembly is necessary with the Airtherm Gas or Oil Fired Heater. Units are shipped from the factory, ready for installation, representing a saving in initial cost.

Nine capacities, from 650,000 to 1,950,000 B.T.U.'s.



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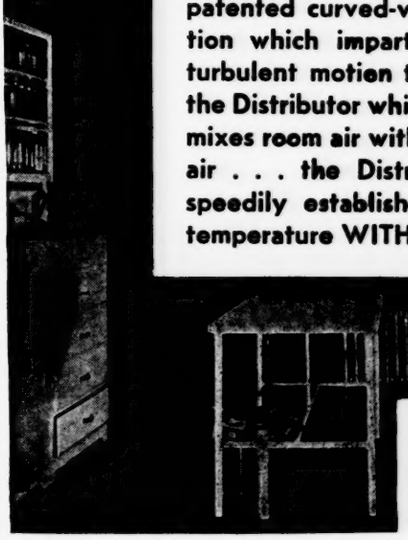

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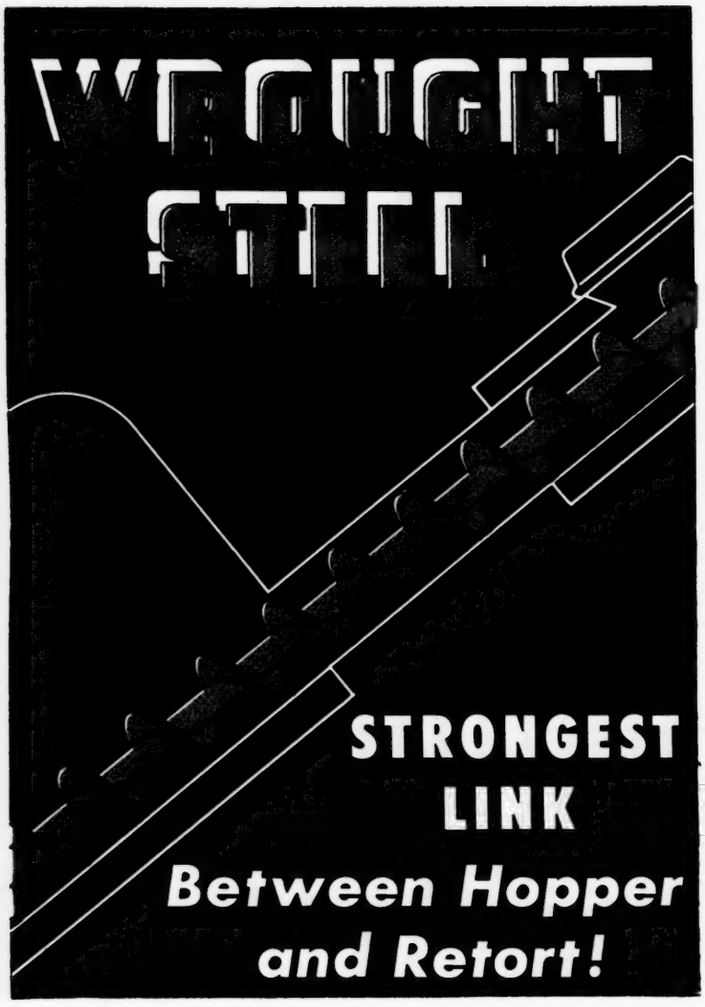

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Welding Procedure

A service bulletin covering recommended practices for welding and flame cutting of wrought iron pipe and flat rolled products now is available for distribution. The book contains a comprehensive welding chart that can be removed and tacked on a wall.—*A. M. Byers Co., Pittsburgh, Pa.* **46**

Fuel Filters

A 4-page, stiff paper folder containing a capacity chart, dimensions and specifications of the Briggs Z series fuel filters.—*The Briggs Filtration Co., Bethesda 14, Md.* **47**

Boilers

Bulletin No. B-3 covers a line of full-length and submerged fire-tube boilers. These boilers range in capacity from 3 to 110 hp. They may be manually or mechanically fired. They are particularly adapted for installation where space limitation, portability, and price are controlling factors.—*The Brownell Co., 410 N. Findlay St., Dayton 1, Ohio* **48**

Aluminum

The role of aluminum in architecture is described in a 12-page catalog, No. 104-A.—*Reynolds Metals Co., Inc., Aluminum Division, 2500 S. 3rd St., Louisville 1, Kentucky.* **49**

Underground Pipe Insulation

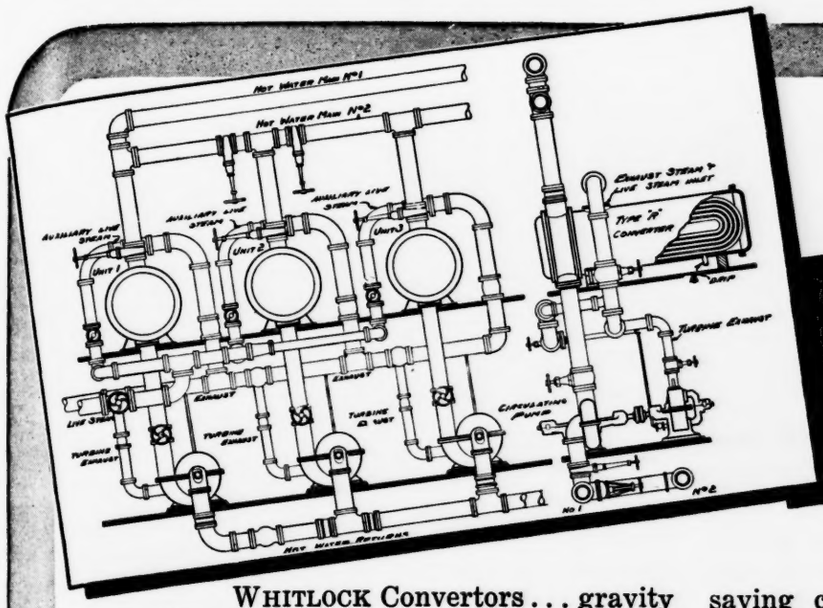
A 4-page folder describes "Z" crete, a special mix of insulating concrete for insulation of underground heated piping. Compound is composed of insulating aggregate, cement, and waterproofing and is poured into forms built around piping.—*Universal Zonolite Insulation Co., 135 S. La Salle St., Chicago 3, Ill.* **50**

Rotary Positive Blowers

A 24-page bulletin, No. 22, 23-B-12, covers rotary positive blowers and the applications for which this type of blower has been found useful and efficient, including: chemical process industries, pneumatic conveying service, tunnel ventilation, foundry cupola service, water gas blowing, various combustion processes, coal treatment, vacuum filtration, etc.—*Roots-Connersville Blower Corp., Connersville, Ind.* **51**

Vacuum Process Pumps

Two 4-page bulletins have been released covering vacuum process pumps. One bulletin covers a type PC pump which is said to be widely used in food processing, and especially where low temperature cooking under vacuum is employed. The other bulletin covers a type PT pump which is especially designed for installations where the air stream may contain abrasive powder.—*Whittington Pump & Engineering Co., 245 S. Meridian St., Indianapolis 4, Ind.* **52**



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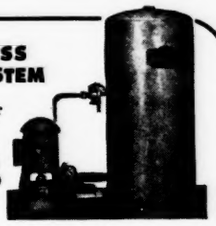

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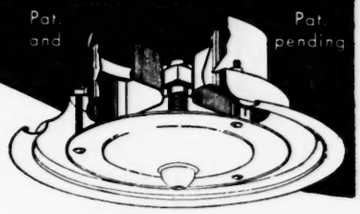

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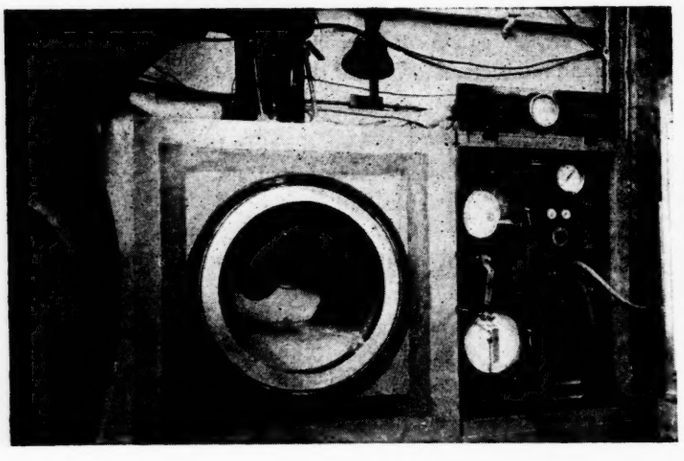

Isometric Drawing Stencils

Entitled "Axonometric Drawing . . . the Universal Picture Language," a new 20-page booklet explains the underlying theories of isometric and dimetric projection. Use of Instrumaster isometric and dimetric stencils is outlined in the booklet as a practical application of the basic theory. Their use permits isometric or dimetric views to be used for tool drawings, piping diagrams, catalog illustrations, part drawings, and views of "exploded assemblies" without extra time or effort.—*John R. Cassell Co., Inc., 110 West 42nd St., New York 18, N. Y.* 53

Try-Cocks

Sealtite try-cocks are described in a 4-page bulletin, No. WG-1815. These try-cocks are available for all boiler pressures and permit frequent check on water level.—*Yarnall-Waring Co., Chestnut Hill, Philadelphia 18, Pa.* 54

Filters

A 44-page, illustrated, indexed catalog of Staynew filters presents a complete line of filters for all types of application. Pipeline filters, air intake filters, liquid filters and ventilation filters of the automatic, dry panel, and viscous panel types are described with tables of sizes and useful application data.—*Dollinger Corp., 11 Centre Park, Rochester 3, N. Y.* 55

Totally Enclosed Motor

An 8-page brochure describes a line of Tri-clad totally enclosed electric motors ranging from 1 to 1000 hp for use in very dusty, dirty, corrosive atmospheres. Motors available in standard, explosion-proof, and dust-explosion-proof types—*Apparatus Dept., General Electric Co., Schenectady, N. Y.* 56

Radiant Heating Controls

"How to Control Radiant Heating," a new 20-page booklet, describes automatic temperature control systems for radiant heating systems and features the weather-controlled Duo-stat in conjunction with room and water temperature controls.—*Johnson Service Co., Milwaukee, Wis.* 57

Refrigeration Valves

A 10-page booklet, "Dependable Refrigeration Valves," describes expansion, solenoid, regulating and other types of valves and accessories for refrigeration installations. Revised price list is included and booklet is perforated for loose leaf binding.—*Automatic Products Co., Milwaukee 10, Wis.* 58

Combustion Chambers

PeTcO interlocking combustion chambers made in both vertical and rectangular types are designed in sections which are true in shape and size and easy to install, according to a description contained in a new folder.—*B. A. Peterson Co., Dowagiac, Mich.* 59

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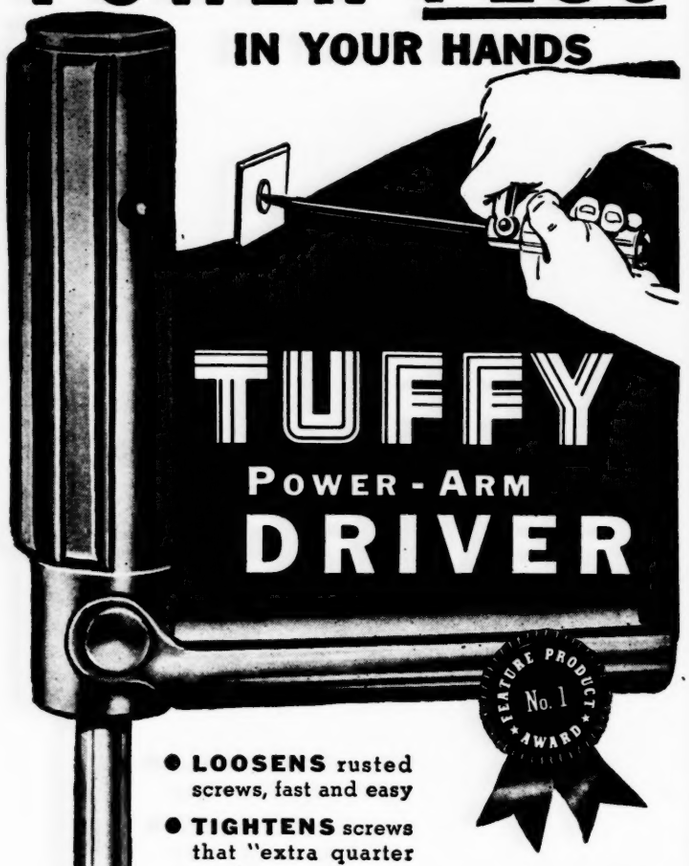

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Air Conditioning

The Store Weathermaster, a self-contained air conditioner, is described as "one of the world's best salesmen" in the latest of Carrier Corp.'s postwar series of catalogs. Written especially to invite attention to sales increases due to comfortable shopping conditions, the catalog features the business-attracting possibilities of Store Weathermasters. Duct-type air conditioning for multi-room buildings is discussed in another of Carrier's postwar catalogue series. The Duct-type Weathermaster system is recommended especially for commercial buildings from one to five stories high.—*Carrier Corp., Syracuse, N. Y.* 60

Duplicating Machines

Catalog No. 46-10 summarizes developments in "Die-Less Duplicating" during war years and describes a line of duplicating machines designed to produce small parts of various shapes and radii. Feature of these machines is that they create pieces which have a die-cut appearance without the necessity of forming dies.—*O'Neil-Irwin Manufacturing Co., Minneapolis 15, Minn.* 61

Boiler Feed Case Study

Bulletin 453 is an 8-page case study of controlling boiler feed water for the new generating station at the New York Naval Shipyard written by the master mechanic at the station and including illustrations, charts and tables of significant data.—*Northern Equipment Co., 1351 Grove Dr., Erie, Pa.*.....62

Conductivity Cells

A comprehensive survey of conductivity checking equipment for laboratory and plant use is provided in a catalog, "Conductivity Cells," which deals primarily with a wide selection of conductivity cells for the checking of various liquids under varying conditions. There is a ready reference chart for selecting cells. The catalog also deals with sample coolers and cell holders for boiler water and steam condensate testing. —*Industrial Instruments, Inc., 17 Pollock Ave., Jersey City 5, N. J.*.....63

Instruments and Gauges

A new 40-page full-color catalog featuring industrial instruments and gauges has been prepared and is now available. Included are complete descriptions and applications of the following instruments and gauges: pressure gauges, vacuum gauges, retard gauges, compound gauges, compound retard gauges, back connected pressure gauges, combination altitude pressure and thermometer gauges, altitude gauges, internal syphon pressure gauges, sprinkler system gauges, recording gauges, indicating and recording thermometers, portable recording thermometers, standard chart ranges, bulbs and special equipment, transformer thermometers, indicating themometers for freezing and dispensing cabinets and indoor-outdoor thermometers.—*The Electric Auto-Lite Co., Instrument and Gauge Div., Chrysler Building, New York, N. Y.*.....64

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A great percentage of the conditioned air that is exhausted because it is stuffy and stale can be converted to fresh air by the activated carbon in Dorex Air Recovery Units and recirculated.

YOU can save fuel, power and equipment, for in every case where a Dorex unit has been applied, it has converted stale, contaminated air to fresh air at a cost considerably lower than the cost of bringing in and conditioning outdoor air. A variety of Dorex unit types and sizes permits easy installation in almost every existing or planned air conditioning system.

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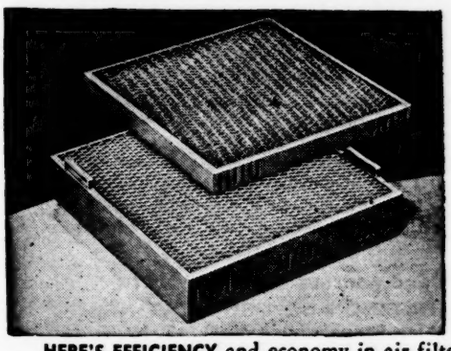

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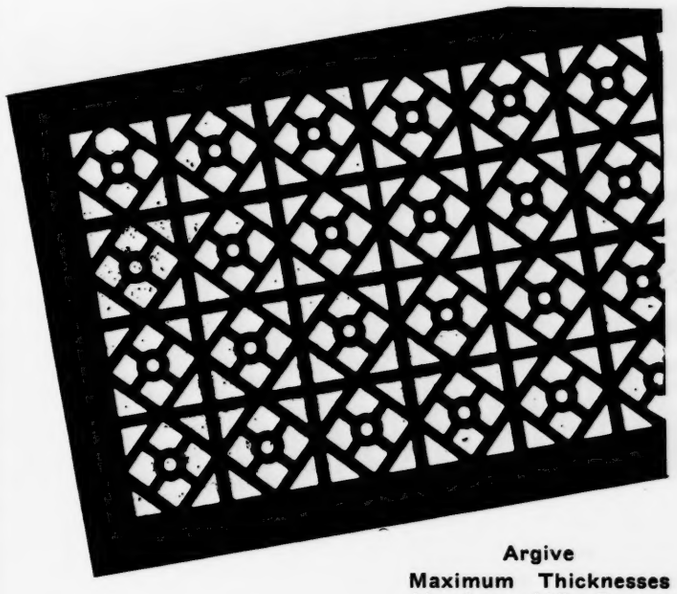

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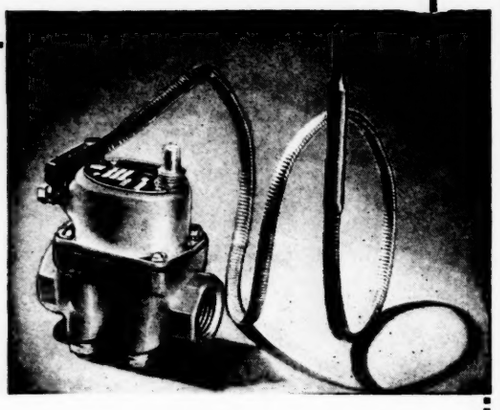
New MR-2 SAFETY THERMOVALVE



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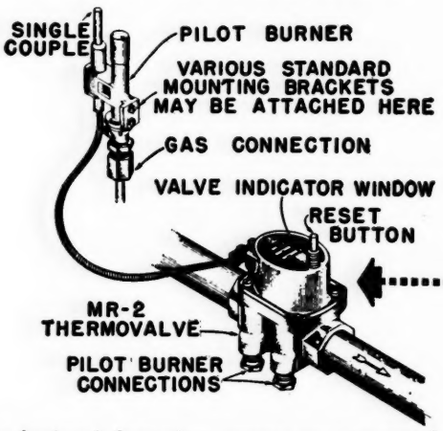

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15-2

Multiple V-Belt Drive

"How The Dominant Drive Speeds Production, Reduces Costs" is the title of a 16-page, illustrated booklet recently published by the Multiple V-Belt Drive Association. Written for laymen, the booklet does not go into engineering details of the multiple V-belt drive. Instead, it presents the results of these engineering features in terms of operating advantages to drive users. The booklet is specially written for executives and foremen responsible for efficient and economical plant operation.—*Multiple V-Belt Drive Association, 22 West Monroe St., Chicago 3, Ill.* 65

Water Level Control

Bulletin 449, four pages on control of feed water flow and water level on a chemical plant's Foster Wheeler Type S-A steam generator. Charts and tables give significant data.—*Northern Equipment Co., 1051 Grove Drive, Erie, Pa.* 66

Strainers and Separators

A new 16-page two color illustrated bulletin, No. 46-50, describes a complete line of strainers and separators. The bulletin gives dimensions and list prices on strainers for water or oil service, horizontal and vertical separators for steam, air or gas service as well as receiver separators for various installation conditions.—*American District Steam Co., North Tonawanda, New York* 67

Solenoid Valve

All pertinent information concerning their new V5-100 Solenoid Valve which, despite its small size, operates at pressures up to 150 psi, is to be found in a bulletin issued by the Allied Control Valve Co., Inc. According to the bulletin, the valve features soft seats to assure a positive seal—and all parts coming in contact with the media are of stainless steel to prevent possible oxidation or corrosion. Sectional drawings, mounting diagrams and detailed specifications are included in the bulletin.—*Allied Control Valve Co., Inc., South Norwalk, Conn.* 68

JULY, 1946

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TIME SWITCH is Well Engineered

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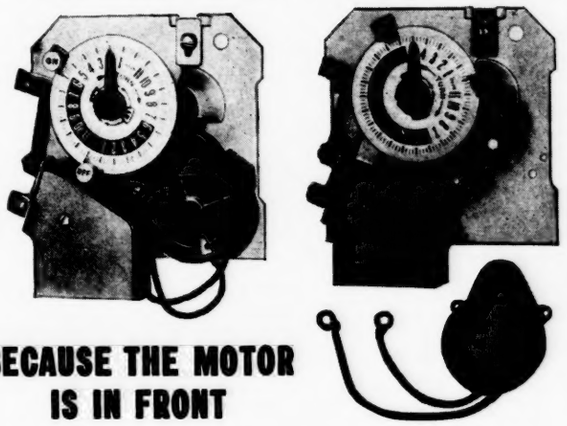

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INDUSTRIAL DEGREE-DAYS

May, 1946

City	55F Base	45F Base
Baltimore, Md.	8	0
Buffalo, N. Y.	86	3
Chicago, Ill.	66	1
Cleveland, Ohio	45	0
Detroit, Mich.	52	0
Indianapolis, Ind.	13	0
New York, N. Y.	19	0
Philadelphia, Pa.	11	0
Pittsburgh, Pa.	18	0
St. Louis, Mo.	10	0

Canadian Degree-Days for May, 1946*

City	May 1946	May Normal	Cumulative, Sept. 1 to May 31 1945-46	Cumulative, Sept. 1 to May 31 Normal
Calgary, Alta.	536	480	8823	9111
Charlottetown, P. E. I.	468	536	7946	8263
Crescent Valley, B. C.	288	403	7034	7731
Edmonton, Alta.	471	428	9752	9797
Fort William, Ont.	589	567	10054	10045
Grand Prairie, Alta.	400	505	10660	10122
Halifax, N. S.	470	493	7139	7395
London, Ont.	353	307	7186	7275
Medicine Hat, Alta.	434	301	8354	8495
Moncton, N. B.	462	474	8447	8568
Montreal, P. Q.	362	325	8291	8413
North Bay, Ont.	546	434	9572	9180
Ottawa, Ont.	384	310	8453	8674
Penticton, B. C.	198	273	6127	6346
Porquis Junction, Ont.	691	558	10996	11144
Prince George, B. C.	397	490	8713	8996
Quebec City, P. Q.	409	428	8761	9276
Regina, Sask.	527	434	10560	10891
St. John, N. B.	496	505	7868	8081
Saskatoon, Sask.	487	397	10617	10478
Toronto, Ont.	346	341	6754	7236
Vancouver, B. C.	267	326	5210	5303
Victoria, B. C.	285	366	4821	4935
Windsor, Ont.	282	251	6289	6705
Winnipeg, Man.	453	397	10393	10841

*These data are supplied through the courtesy of the Meteorological Division, Air Service Branch, Department of Transport, Canada, with the cooperation of N. W. Etter, Heating Engineer, Enamel & Heating Products Limited, Sackville, N. B.

*The Department reports some slight revisions in the figures for April, as published in last month's issue. Corrected figures are: Montreal, P. Q., 687; Penticton, B. C., 522; Quebec City, P. Q., 822.

. . . Since the Last Issue

Appointments by **Carrier Corp.** for four men in the Syracuse, New York, organization have been announced by Arthur P. Shanklin, vice-president in charge of dealer sales. The appointments are: **S. H. Ellison** as manager of product distribution, in addition to his present duties as assistant to the vice-president in charge of manufacturing; **W. W. Bryant, Jr.**, as assistant manager of product distribution; **J. A. Palmore** as manager of the sales order department; and **E. C. Weaver** as manager of the warehouse-shipping department.

Theodore J. Kauffeld and **B. Winthrop Pizzini** have been elected to the board of directors of **Howell Electric Motors Co.**, Howell, Michigan, according to an announcement made by Aubrey C. Flood, President. Mr. Kauffeld is president of Devenco, Inc., Consulting Engineers, New York, and Mr. Pizzini is head of B. W. Pizzini Company of New York.

Tal's Prestal Bender, Inc., of Milwaukee, Wis., have recently occupied their own building at 417 North Water Street. It meets the problem of more space required for the increasing volume of business being received.

Radiant Panel Heating, Inc., a corporation formed by men living in the lake area, has been approved by the State of Michigan. The founder of the new organization is **William Woodbridge**, a master plumber and a member of ASHVE, who has been active in this territory for twenty-five years. He is a resident of Commerce. The company has been formed as a means of giving to the public a modern engineered service in plumbing and heating. The new corporation has been formed on a profit sharing basis with the men who have been employed by Woodbridge Plumbing and Heating.

The addition of four new sales engineers has been announced by the **Young Radiator Co.**, manufacturers of heat transfer equipment. **W. H. Schmeling**, a graduate of Marquette University school of Engineering and former AAF weather officer in the South-West Pacific, is active in the solution of special radiator cooling problems. Also a graduate of Marquette University school of Engineering and a former torpedo officer in the U. S. Navy, **A. D. Bogus** is

W. H. Schmeling

A. D. Bogus

specializing in the petroleum field and engine jacket water cooler heat transfer engineering service. **Edward C. Uecker**, long in service with General Electric Co. in turbine generator and turbo-supercharger work, will serve Young Radiator Company's customers in the specialized field of aircraft heat transfer problems including lube oil cooling, supercharger intercooling and aftercooling, gas turbine regenerator cycle cooling, etc. Mr. Uecker is a graduate

E. C. Uecker

M. H. Canham

of the University of Wisconsin, school of Engineering. Leaving school to serve as an AAF gunnery officer, **M. H. Canham** returned to the University of Illinois, School of Engineering, to graduate as a mechanical engineer after being honorably discharged from the Air Forces. Mr. Canham is serving the customers of Young's heating, cooling, and air conditioning division in the proper selection and application of this type of equipment.

The Hoffman Specialty Co., embarking on a program of expansion, recently added a broad line of heating controls to the products distributed through heating and plumbing wholesalers. The company has also put in production a new oil burning furnace for small homes.

AIR CONDITIONING
...to be seen and not heard
When you need ribbons on the ducts to show your air conditioning in operation —then noise and vibration have successfully been eliminated.
And Korfund Vibration Control assures you of this important benefit. Engineered especially for your needs, Vibration Control prevents disturbance caused by machinery in motion.
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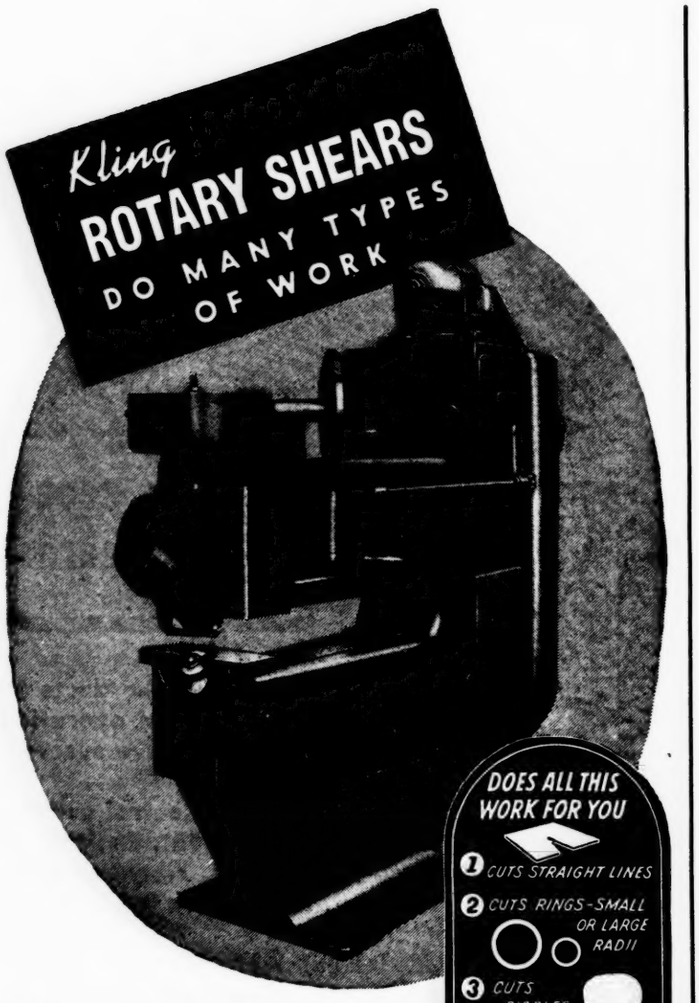
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ROTARY SHEARS
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DOES ALL THIS WORK FOR YOU
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2 CUTS RINGS-SMALL OR LARGE RADII
3 CUTS CIRCLES
4 MAKES FLANGES
5 CUTS INSIDE HOLES WITHOUT CUTTING IN FROM EDGES
6 JOGGLES & OFFSETS
7 CUTS ODD SHAPES
8 BEVELS OF ANY ANGLE
9 CUTS REVERSE CURVES
10 BEADS & U'S
ALL WITH Hairline PRECISION

Yes, and With Hairline Precision

Rapid operation . . . Hairline Accuracy . . . the use of Kling Rotary Shears marks the latest development in cutting mild steel, and sheet metal, up to 1-inch with amazing savings in time, labor, and production costs.

For exacting projects (see illustration at the right), no single unit of metal-working equipment does so many different things so cleanly and efficiently as does the Kling Rotary, pictured above.

In metal working plants, automotive, aviation, home appliance, and other industries, where work of this character is being done, — this machine is held in high regard for its versatility and economy of operation.

This great usefulness is the result of half-a-hundred years of engineering experience which prospective buyers, with reason and respect, applaud.

Send Today for Bulletin No. 245 which will give you specific facts, and specifications. No obligation involved. Users of heavy equipment of Kling Rotary Shears' class will receive a copy of this Bulletin promptly, on request.

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Harry E. Kent has been appointed director of Engineering of the **Edison Electric Institute,** effective as of June 30, 1946. Mr. Kent succeeds Alexander Maxwell, whose retirement takes place at the end of June. For a number of years Mr. Kent served as principal assistant to Mr. Maxwell and his entire professional career has been devoted to engineering activities of the institute and its predecessor organization.

D. P. O'Keefe, president of O'Keefe & Merritt Co., Los Angeles gas range manufacturers, was elected president of the **Gas Appliance Manufacturers Association** at the annual meeting of the association held in Chicago. The association's other newly elected officers are: 1st vice-president, **John Robertshaw,** president, Robertshaw Thermostat Co.; 2nd vice-president, **Frank Hoenigmann,** executive vice-president, Florence Stove Co.; treasurer, **John Van Norden,** secretary, American Meter Co.

D. P. O'Keefe

Additions to the New York factory branch sales staff have been announced by **General Controls Co.,** Glendale, Calif. **F. E. Weldon,** graduated from Rensselaer Polytechnic Institute as an industrial engineer, has been active in the electrical and mechanical control industries with Westinghouse in New York and Arens Controls in Chicago. **A. C. Kelterborn,** an alumnus of Cornell University, is an experienced sales and consulting engineer in the electrical field. He was formerly associated with the Hunter Fan and Ventilation Co., and Burns and Roe, consulting engineers, in New York. The New York factory branch serves users of automatic pressure, temperature, and flow controls in New York state, New Jersey and Connecticut.

Four new appointments have been announced by **Ilg Electric Ventilating Co.,** Chicago. **F. H. Bigelow** has been named manager of the Ilg office in Atlanta, Ga. Replacing Mr. Bigelow as manager of the Memphis office is **H. H. Wilson,** recently released from the Navy. In Knoxville, Tenn., the Ilg office has been re-opened under the supervision of **E. Lloyd Widner,** manufacturers representative for the last twelve years. In Louisville, Ky., **Henry M. Lutes** has been established as manager of the Ilg branch office. These moves bring the total number of Ilg branch offices in principal cities to forty-three.

Alfred B. Drastrup has been appointed manager of the Alloy Steel Sales Department of **A. M. Byers Co.** Mr. Drastrup has been associated with A. M. Byers since 1931 in accounting, industrial engineering and plant management capacities and previously was with the Columbia Steel Company, Torrance, Cal., and the Gary Works of the U. S. Steel Corporation, Gary, Ind. He was born in Denmark and received his education in business administration and accounting both in that country and the United States.

A. B. Drastrup

Correction: In an item in this department in June covering changes at The Permutit Co., names under the photographs of A. D. Way and H. L. Beohner were transposed. Also note correction in spelling of the latter name.

Professor Mario C. Giannini, associate professor of mechanical engineering and director of the evening division of the College of Engineering **of New York University,** has been appointed executive assistant of the College of Engineering. Professor Giannini became a member of the University faculty in 1926. He is a member of the ASHVE; the Board of Governors, New York Chapter ASHVE; Metropolitan Committee, National Fuel Efficiency Program, U. S. Department of Interior; Board of Engineers, Manpower Utilization Committee of the War Manpower Commission; and Society for the Promotion of Engineering Education. He has served as a consulting engineer in heating, air conditioning and mechanical equipment of buildings, and as a consultant to publishers on engineering and technical textbooks. He is an adviser to the Division of General Education of New York University on vocational-technological training.

Jas. Emmett, Jr., vice-president of the **Marsh Heating Equipment Co.,** 2073 Southport Ave., Chicago 14, Illinois, a Division of the Jas. P. Marsh Corp., has entered the hot water heating field with a full line of hot water heating specialties. This line includes circulating pumps, flow control valves, air eliminators, supply tees, expansion tanks, indirect heaters, tankless hot water heaters, relief valves, pressure reducing valves and control units. With the advent of this line, in conjunction with the already established line of steam heating specialties and heat control regulators, the company is now in a position to supply heating jobbers and contractors with all necessary heating specialty items to meet stocking and individual heating installation requirements.

J. Emmett, Jr.

The opening of a new branch office in Pittsburgh, Pa., has been announced by the **Herman Nelson Corp.,** Moline, Illinois. This branch office becomes No. 13 in a nation-wide chain. It will be in charge of **Gale Heslop** as general product application engineer. Mr. Heslop was formerly connected with the Washington branch office operating out of Baltimore, Maryland. **J. M. Osborne,** general product application engineer, will be in charge of the Washington branch office. Another change finds **Coleman J. Kane** taking charge of the New York City branch office as general product application engineer. From 1942 to 1946 Coleman Kane served with the U. S. Navy aboard a destroyer with duty in the North Atlantic, So. Pacific and Mediterranean. After his discharge he rejoined the Herman Nelson Corp., and was associated with the New York branch office.

Walter P. Berg has been appointed general manager of the **Machinery Division** of **Dravo Corp.** Mr. Berg assumes the duties of **W. K. Fitch,** who recently became Dravo board chairman. Activities under Mr. Berg's supervision will include the furnishing and installing of heavy machinery, Dravo heating, power plant construction, and the products of other firms involved in the completion of Dravo installations. Mr. Berg graduated from Lehigh University (ME degree) in 1917 and came with Dravo as an Assistant Engineer in 1923. Since 1938 he has been in charge of the Power Department of Dravo's Machinery Division.

Max H. Foley of the architectural firm of Voorhees, Walker, Foley & Smith was reelected president of the **New York Building Congress, Inc.,** at the twenty-fifth annual meeting of the Congress on May 29.

Your own Plant will give you more Production and better quality when you install . . .

NIAGARA Duo-Pass AERO CONDENSERS

NIAGARA Duo-Pass AERO CONDENSERS provide a sure method of increasing the refrigeration capacity of a system that has been in use for several years. Its increased condensing capacity, made into a permanent gain by the exclusive Duo-Pass pre-cooling method, results in both power savings and extra refrigeration capacity from your compressors. Using outdoor air as the cooling and condensing medium, the Niagara Aero Condenser removes 1000 BTU from the refrigerant gas per pound of water consumed, providing a saving in the cost of condenser water that quickly returns the cost of installation.

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3 Ways to Perfect Sprays
Atomizing Nozzle for any service requiring a mist-like spray
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Air Conditioning HEAT EXCHANGERS

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Let our engineering department help you with your problem

Conseco 15 ton freon heat exchanger, Strand Theatre, N. Y.

Twenty years' specialized experience designing, fabricating and servicing heat exchangers assure sound design, quality construction and economical operation with any type refrigerant. Engineering assistance gladly furnished. Write.

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TUBE CLEANING GUNS AND PLUGS
AIR AND EROSION ELIMINATORS
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STRAINERS, GREASE EXTRACTORS
WIZARD INJECTORS, FILTERS
CONDENSERS • LOW PRESSURE EVAPORATORS • AIR EJECTORS • HEAT EXCHANGERS • PUMPS

William B. Walrath, Jr., has been appointed advertising manager of the **Minneapolis-Honeywell Regulator Co.**, it was announced by C. B. Sweatt, executive vice-president. Until his new appointment. Walrath was director of research for Addison Lewis and Associates, Minneapolis agency. He succeeds **George Benton** who has been appointed personnel manager. **Chandler Murphy**, who has been acting advertising manager, has been named assistant to the sales promotion manager, for the company. A lieutenant commander in the Navy, where he served as instrument flight instructor, Mr. Walrath joined the Lewis agency in November of last year. Prior to his Navy service, he was assistant research director in the Chicago office of Batten, Barton, Durstine and Osborne, Inc., and later western advertising manager of Young America magazine.

W. B. Walrath, Jr.

Howard N. Eavenson, president of **Bituminous Coal Research, Inc.**, the national reseach agency of the bituminous coal industry, has made three appointments to the BCR Technical Advisory Board, naming **C. R. Mabley, Jr.**, of Huntington, W. Va., **John Mitchell** of Boston, Mass., and **Charles J. Surdy** of New York City. Mr. Mabley, general manager of industrial sales for Island Creek Coal Sales Company, will serve on the industrial utilization and residential stoker sub-committees. Mr. Mitchell, a gas engineer representing the Koppers Coal Division of Eastern Gas & Fuel Associates, also will serve on the residential stoker sub-committee as well as with the gasification and carbonization sub-committee. Mr. Surdy, vice-president of The Standard Stoker Company, Inc., is expected to be active on the motive power sub-committee, another new member of which is **A. J. Townsend**, vice-president in charge of engineering, Lima Locomotive Works, Inc., Lima, Ohio. Julian E. Tobey, director, Fairmont Coal Bureau, New York City, is chairman of the TAB, a group of 37 fuel engineers which serves the national research agency in an advisory capacity.

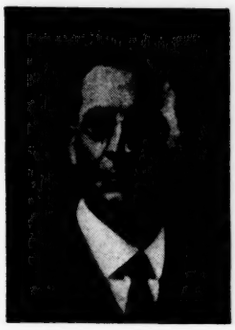
Westinghouse Electric Corp. has announced the appointment of **Harold C. Hickock** as Central District manager of the **B. F. Sturtevant Co.** Division of Westinghouse with headquarters in Pittsburgh, Pa. Mr. Hickock was graduated from Worcester Polytechnic Institute, Worcester, Mass., with a degree of electrical engineer in 1918 and joined Westinghouse immediately in the railway engineering section of the General Engineering Department. When the Westinghouse Electric Elevator Company became an integral part of the parent Company last year, Mr. Hickock was appointed Central District manager of the Elevator Division of Westinghouse in Pittsburgh—a post he now leaves to join the Sturtevant Division of the Company. At the same time it was announced that **Dallas W. Norris**, manager of the St. Louis District of the Elevator and Air Conditioning Division, has assumed the post vacated by Mr. Hickock. Mr. Norris is a native of Pittsburgh and joined the Westinghouse Company in 1923 as a test course student. He was transferred to the Elevator Company in 1928 and made Cleveland Manager five years later, and in 1942 was appointed St. Louis District Manager.

The appointments of **H. A. Klug** as merchandise manager and **J. B. Baughman** as product supervisor in the Refrigeration Specialties department at the East Springfield, Mass., works of Westinghouse have been announced. As merchandise manager Mr. Klug will be responsible for sales of the department's products—milk, beverage and water coolers, farm freezers, room air conditioners, reach-in refrigerators and condensing units for other types of commercial refrigeration—to distributors, dealers, and manufacturers. Mr. Baughman will be in charge of product development and production.

The **Herman Nelson Corp.** of Moline, Illinois, announced several changes in personnel and additions to their sales staff. **C. R. Anderson,** formerly advertising manager, has joined the Philadelphia branch office in the capacity of product application engineer. **W. M. Walterskirchen** is the new product application engineer in Missoula, Montana, and **Norman Omodt** is enrolled in a sales training course at the home office, before entering the sales field. With the inclusion of these three new engineers the sales force of the Herman Nelson Corporation now includes fifty-six men in a network covering the United States. Mr. Anderson's position as advertising manager is now being filled by **R. E. Froeschle** who has returned after two and one-half years in the Navy. Mr. Froeschle is a graduate of the University of Missouri School of Journalism, where he majored in Advertising. Mr. Walterskirchen rejoins the staff after serving as a Captain in the U. S. Army. Mr. Omodt, recently discharged from the Army after four years of service, is starting new with the corporation. He graduated from Washington State University in 1942, with a BS degree in Mechanical Engineering.

A. B. Morgan has been appointed assistant managing director of the **Edison Electric Institute,** according to an announcement by Col. H. S. Bennion, vice-president and managing director of the institute. Mr. Morgan has been the rate and power consultant for EEI, heading both the rate and general service departments. In his new position he will assist Col. Bennion in the supervision of the institute's operations, and will also continue his present responsibilities. A graduate of Massachusetts Institute of Technology, Mr. Morgan joined the National Electric Light Association, predecessor of EEI, in 1927 as an assistant engineer. He specialized in codes and standards activities, representing the electric light and power group on committees of the American Standards Association. During this period, he also organized and conducted the first industry investigation of load characteristics of oil burners, and a comprehensive study of water heater load characteristics.

Getting Personal



J. B. Kincer

J. B. Kincer *(Is Our Climate Getting Cooler?* page 59) is a native of Virginia. He was educated in public and private schools and taught school in Virginia for five years, after which he became Deputy Treasurer of Wythe County. In 1905 he entered the U. S. Weather Bureau as assistant observer and advanced through various grades to principal meteorologist and chief of the Division of Climate and Crop Weather. In September, 1944 he retired from active service with the Weather Bureau but continues activities as editor of the Meteorological section of the Transactions of the American Geophysical Union. Fellow American Association for the Advancement of Science; Member American Geophysical Union; American Meteorological Society (president 1936-37); International Climatological Commission; International Commission on Agricultural Meteorology. Author of Climatic Section of Atlas of American Agriculture; "Climate and Weather" of the United States, 1941 Yearbook, Department of Agriculture, edited for many years the Weekly Weather and Crop Bulletin, U. S. Weather Bureau, and author of numerous papers and pamphlets dealing with climate and agricultural meteorology.

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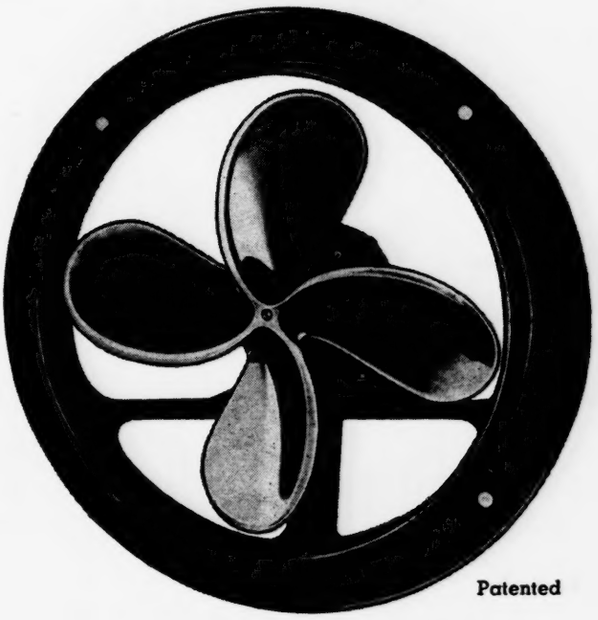

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